technical information

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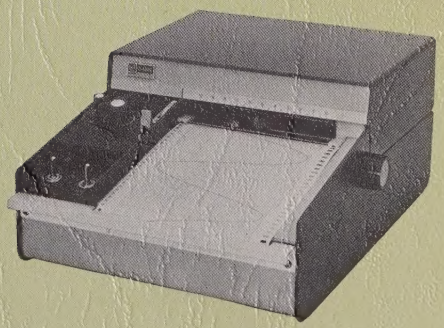
series
G-1000
strip chart recorders



INSTRUCTION MANUAL

SERIES G-1000
STRIP CHART RECORDERS

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WARRANTY STATEMENT

Recorder products manufactured by the Recorder Division of Varian Associates are warranted to be free from defects in materials and workmanship. Liability under this warranty is limited to service or adjustment of equipment returned to the factory for that purpose and to replacement of defective parts. Expendable parts,e.g., mercury cells, vacuum tubes, and fuses are excluded from this warranty. The warranty is effective for one year from the date the equipment was shipped.

Terms of warranty are:

1. Notification of the malfunction or irregularity must be received by Varian Recorder Division Representative within the warranty period. Notification must include a full description of difficulties encountered, the model and serial number of the equipment,name of representative from whom the equipment was purchased,and the original shipping date.

2. The equipment must be determined by Varian or its representative to have become defective through no fault of the owner (user).

Should it become necessary to return an instrument for warranty repair, please follow the instructions in paragraph 4.2- FIELD AND FACTORY SERVICE.

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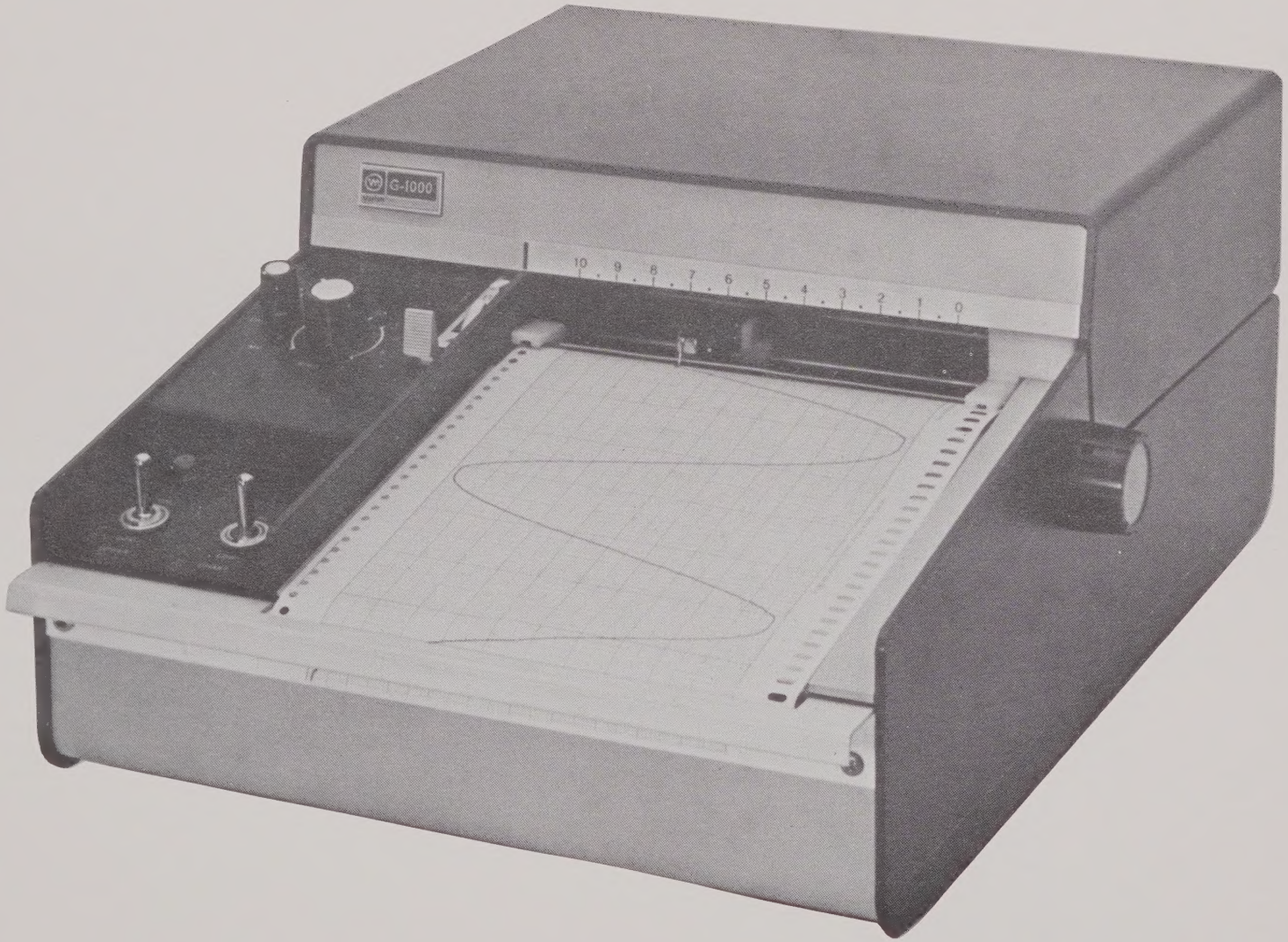
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SECTION 1
INTRODUCTION

1.1 GENERAL

Varian Series G-1000 five-inch strip chart recorders are null-balance potentiometric instruments for use with laboratory and process control readout devices. These solid-state recorders are functionally styled to complement the many popular types of modern analytical instruments now in service. The bench-top configuration provides a large number of operator conveniences.

Both multiple and fixed span versions are offered; the multispan model is designated G-1010, the fixed span model is G-1110.

Special versions can be supplied for specific applications, such as readout of gas chromatography signals where a low-pass input filter is included.

The multiple span recorder has a 10-position calibrated span switch with vernier control allowing operator choice of spans from 1 millivolt to 1 volt. With the fixed-span recorder, a plug-in span element replaces the 10-position switch.

Each recorder is supplied with one chart drive motor and a 4-position thumbwheel chart speed shifter (RATIO control) which provides four speeds in ratios of 1,2,4, and 8. An optional second chart drive motor furnishes four more chart speeds, making a total of eight speeds available to the operator. Either or both motors may be changed in the field to obtain other chart speeds as desired.

Other accessories include event markers, alarm/control switches, and a folded chart paper system, all of which can be either field or factory installed. Accessories which must be factory installed are a Disc integrator, reversed polarity circuitry, and an electric pen lifting mechanism.

1.2 CONSTRUCTION

The basic recorder is constructed on a sheet metal chassis. All mechanical and electromechanical components are mounted on this chassis assembly. The platen, offering ample space for making chart notations, is hinged for easy chart paper loading, and a chart paper tear-off bar is mounted across the front of the recorder. The top is hinged and tilts upward to provide quick

access to the ink system and the optional integrator switch.

The power switch with indicator light and the chart drive motor switch are conveniently located on the control panel at the front of the recorder. On the multiple span unit, the span switch and vernier control are also located on the control panel. Signal input terminals, plug-in fixed span element, accessory connector, fuse holder, power cord input, and calibration controls and adjustments are located at the rear of the chassis.

1.3 SPECIFICATIONS

All specifications apply to line voltage of 105-125 vac at 60 ±2Hz or 210-240 vac at 50 ±2Hz

Span (full scale voltage)	
Model G-1010	10-position, calibrated switch: 1 mv, 2 mv, 5 mv, 10 mv, 20 mv, 50 mv, 100 mv, 200mv, 500 mv, and 1 volt. Uncalibrated potentiometer for adjustment between spans.
Model G-1110	Fixed span, plug-in element.
Input	Floating, differential; input signal may be 200 vdc, maximum, above chassis ground. Low pass input filter optional.*
Input Resistance	Potentiometeric on 1 mv through 100 mv spans; 1 megohm on 200 mv through 1 volt spans; 50K ohms on uncalibrated spans.
Permissible Source Resistance	Up to 50K ohms on calibrated spans.
Line Frequency Rejection	
Normal Mode (Transverse)	60 db (1000 to 1)
Common Mode (Longitudinal)	140 db (10^7 to 1)
DC Rejection	140 db or 200 volts, whichever is less.
Pen Response (50 and 60 Hz)	0.35 second, full scale.
Accuracy	0.25% of full scale.

* Low pass filter affects pen response, line frequency rejection, and permissible source resistance specifications.

1.3 Continued

Sensitivity	0.1% of full scale (5 inch span), or 1 microvolt, whichever is greater.
Reference Voltage	Electronically regulated (Zener).
Zero Adjustment	Full Scale.
Zero Suppression	One scale width.
Damping	Adjustable. Changes in damping do not affect dc calibration.
Ambient Temperature	32° to 110°F. (except with water-base ink).
Paper	W = 6-3/8 inches; L = 85 feet.
Grid Size	5" maximum.
Dimensions	H = 6-1/4"; W = 11-3/8"; D = 15-1/2"
Weight	Net: 18 pounds; Shipping: 23 pounds.
Power Requirements	105 to 125 vac or 210 to 240 vac; 58 to 62 Hz or 48 to 52 Hz; 30 watts.

TABLE I
Chart Speeds

Set	Position 1	Position 2	Position 4	Position 8
	(Inches per Hour)			
A	1/12	1/6	1/3	2/3
B	1/6	1/3	2/3	1-1/3
C	1/2	1	2	4
D	2	4	8	16
E	2-1/2	5	10	20
F	4	8	16	32
G	5	10	20	40

1.3 Continued

Set	Position 1	Position 2	Position 4	Position 8
P	7-1/2	15	30	60
H	10	20	40	80
		(Inches per Minute)		
J	1/4	1/2	1	2
K	1/3	2/3	1-1/3	2-2/3
L	2/3	1-1/3	2-2/3	5-1/3
M	1	2	4	8
N	2	4	8	16

One chart drive motor provided; second optional. Customer's choice of basic chart speed (Position 1) which provides three additional speeds (Positions 2,4,8) using chart speed shifter (RATIO control). Other speeds on special order.

1.4 EQUIPMENT SUPPLIED

The recorder is shipped with all of the necessary components required for immediate operation. Standard items and supplies include:

Varian Part Number	Description	Quantity
87-300-114	Instruction Manual	1
908-049-07	Ink cartridge,blue	2
972-464-01	Pen Assembly	1
907-674	Pen filler	1
972-499	Pen cleaning wire	1 foot
(Per S/O)	Chart paper	1 roll
88-299-450	Motor Oil	1 oz.

1.4 Continued

Varian Part Number	Description	Quantity
972-529	Chart-weight clip	1
907-214	Power cord	1
(*)	Fuse	2
	Registration card	1

1.5 ACCESSORIES AND OPTIONS

1.5.1 Event Marker

The timing of significant events can be marked precisely on the chart by using the optional event marker pen. Dual action marker pens, each capable of marking two events, can be installed in either chart margin, or in both margins. Each pen has a separate ink supply. Operated by positive-acting solenoids and an internal power supply, they require only an external contact closure for actuation. The same internal power supply is used for any combination of event markers and the electric pen lift mechanism. Event markers may be either factory or field installed; see paragraph 2.3.4 for field installation instructions.

1.5.2 Electric Pen Lift

Series G-1000 recorders have provision for factory installation of a solenoid-actuated pen lifting mechanism. Thus, a remote switch or relay can be used to control pen lowering and lifting. The same internal power supply is used for the pen lifting mechanism and any combination of event markers. The electric pen lift is connected through the CHART switch so that the pen automatically raises when the CHART switch is OFF and lowers when the CHART switch is in either the LOW or HIGH position. See the Wiring Diagram in Section 6 for proper connections to the accessory connector at the rear of the recorder. See Table 5-3 for listing of parts.

(*) See paragraph 2.2 for listing of fuses.

1.5.3 Alarm/Control Switches

The recorder may be equipped with up to three simple auxiliary switches that control low-power external circuits. Contacts can be adjusted to operate at various predetermined points across the width of the recorder scale. Contacts are SPDT, momentary actuation. Voltage rating is 250 vac,maximum; current rating is 5 amps, maximum.

Alarm/control switches may be either factory or field installed. See paragraph 2.3.2 for field installation instructions.

1.5.4 Second Chart Drive Motor

The recorder can be equipped with a second chart drive motor which will provide four additional chart speeds. The second motor can be either factory or field installed. See paragraph 2.3.1 for field installation instructions. Standard chart speeds available at the four positions of the speed shifter (RATIO control) are listed in paragraph 1.3. Table 5-1 lists the Varian part numbers for motors and motor assemblies referenced to Position 1 operation.

1.5.5 Folded Chart Paper

Series G-1000 recorders have provision for operation with a convenient type of folded paper which may be used in lieu of conventional roll charts. Each pack consists of a continuous length of paper that is perforated and folded every 7 inches to allow ease of handling and rapid inspection of large amounts of data. Each page in the pack is numbered, and individual sheets can be quickly located and easily removed. Folded packs are available in 200- and 800- sheet sizes. See the Varian Recorder Supplies catalog for part numbers and prices.

1.6 Span Elements

Listed in Table II are the Varian Part Numbers for the standard fixed-span plug-in elements. Others are available on special order.

TABLE II

Span Elements

Span	Varian Part Number
1 mv	972-261-01
2 mv	972-261-03
5 mv	972-261-05
10 mv	972-261-07

1.6 Continued

Span	Varian Part Number
20 mv	972-261-09
50 mv	972-261-11
100 mv	972-261-13
200 mv	972-261-15
500 mv	972-261-17
1 v	972-261-19

SECTION 2
INSTALLATION

2.1 GENERAL

Each Series G-1000 recorder is shipped complete in one commercial-grade shipping container. If the container has been damaged in transit, notation of the damage should be made on the shipping receipt. If the recorder and/or accessory items have been damaged, notify the carrier claim agent. He will provide instructions and forms for reporting and describing the damage.

C A U T I O N

DO NOT ATTEMPT TO OPERATE DAMAGED EQUIPMENT

Send one copy of the carrier claim form to the attention of Marketing Manager, Recorder Division, Varian Associates, 611 Hansen Way, Palo Alto, California, 94303.

When unpacking the recorder, check carefully to insure that all components ordered have been supplied. If there are any discrepancies, notify Varian Recorder Division immediately. The packing box should be retained for use should the instrument need to be returned for repair or accessory installation. Fill out and mail the registration card which insures that the warranty will be validated.

After unpacking the recorder, it should be given a visual inspection as outlined below.

2.2 VISUAL INSPECTION

The recorder and accessory items should be visually inspected to assure that no damage to the equipment has occurred in transit. The points to be covered are the following:

2.2 Continued

1. The pen carriage should move smoothly over the full excursion.

2. All screws should be tightly secured.

3. Check that all switches operate properly.

4. Turn the paper advance knob at the side of the recorder CCW to assure that the sprocket drum turns smoothly. DO NOT ATTEMPT TO TURN THE KNOB IN THE REVERSE DIRECTION.

5. Check that the correct fuse is properly inserted in its holder.

Correct fuse values are as follows:

Power Requirement	Slo-blo Fuse	Varian Part Number
115V, 60 Hz	0.5 amp	67-135-350
230V, 50 Hz	0.25 amp	67-135-325

When the recorder is ready for operation, proceed to Section 3 - OPERATION. Read all applicable paragraphs of Section 3, install chart paper, pen assembly, and ink cartridge, and give the recorder an electrical inspection before operating the instrument for the first time.

After it has been determined that the recorder is operating properly, proceed to paragraph 3.10.1 for detailed operating instructions.

2.3 INSTALLATION OF ACCESSORIES

2.3.1 Installation of Second Chart Drive Motor

STEP 1. Partially disassemble the recorder, following Steps 1 through 8 of paragraph 4.7.

STEP 2. Align the motor to be installed with the holes in the left-hand side frame just to the rear of the present motor. See Figure 2-1.

STEP 3. Fasten the motor in place using two 4-40 screws and lockwashers. Do not tighten.

STEP 4. Place the chart drive motor pinion gear onto the motor shaft. Tighten the set screw in the gear onto the flat side of the shaft.

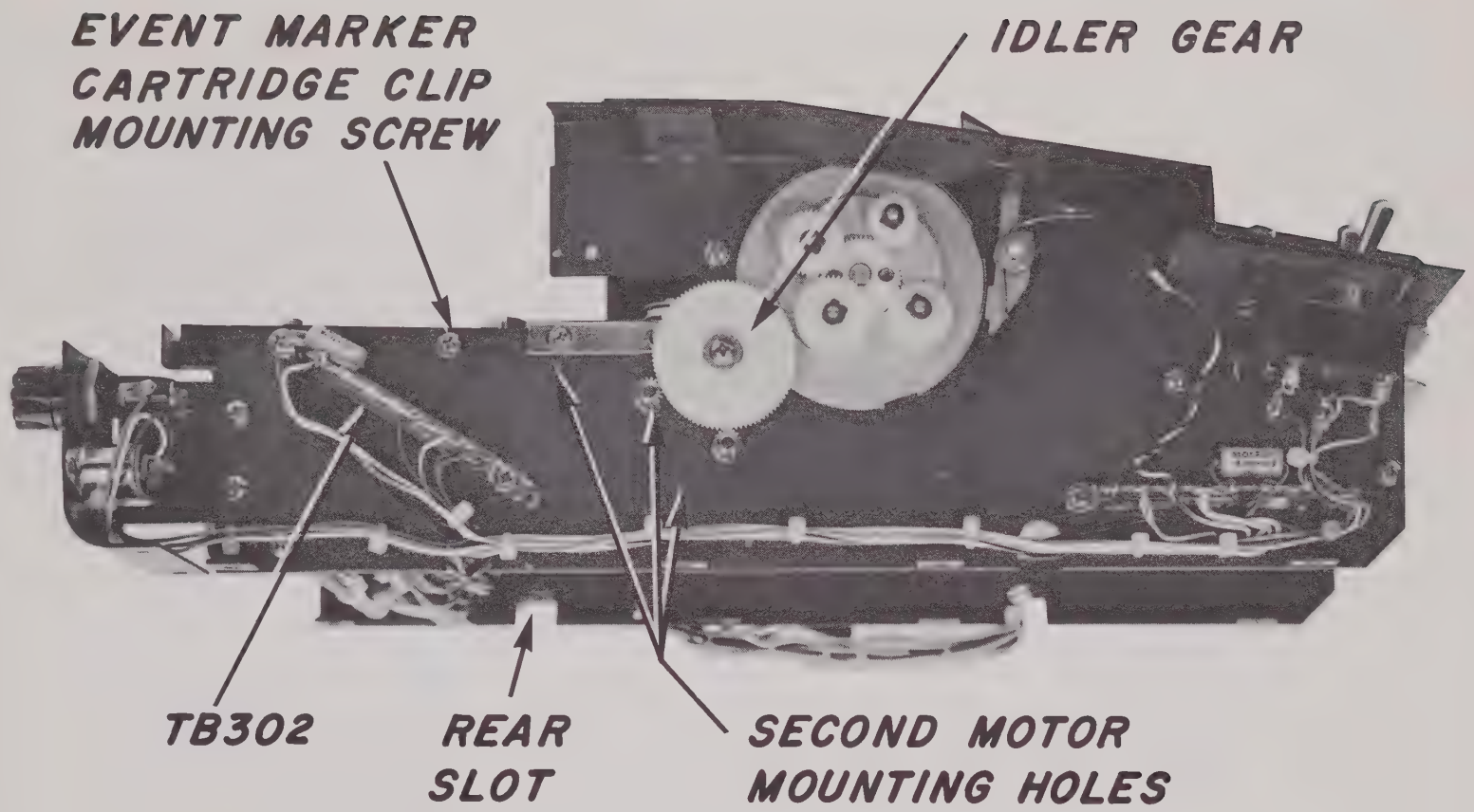

EVENT MARKER
CARTRIDGE CLIP
MOUNTING SCREW
IDLER GEAR
TB302
REAR
SLOT
SECOND MOTOR
MOUNTING HOLES

FIGURE 2-1

2.3.1 Continued

STEP 5. Adjust the motor position so that the motor gear engages the idler. Be sure that minimal backlash exists between the motor gear and idler, i.e., slight mechanical oscillation should exist between the gears.

STEP 6. Tighten the motor screws.

STEP 7. Place the motor electrical leads through the rear slot in the bottom of the left-hand side frame. Connect the leads to terminal board TB302 mounted at the rear of the side frame. See Figure 2-1. See Wiring Diagram, Section 6, for correct terminal connections.

STEP 8. Reassemble the recorder, reversing the procedure of Step 1.

2.3.2 Installation of Alarm/Control Switch(es)

STEP 1. Remove the thumb nut from the alarm/control switch.

STEP 2. Insert the 4-40 switch stud through the alarm/control bracket from the rear. The ears on the switch engage the slot in the bracket.

STEP 3. Replace the thumb nut, but do not tighten.

STEP 4. Mount the alarm/control bracket to the left-hand and right-hand frames with 6-32 screws. See Figure 2-2.

STEP 5. Place the alarm/control switch in its desired position and tighten the thumb nut.

STEP 6. Connect the alarm/control switch electrical leads to accessory connector J406. See Wiring Diagram, Section 6, for correct connections.

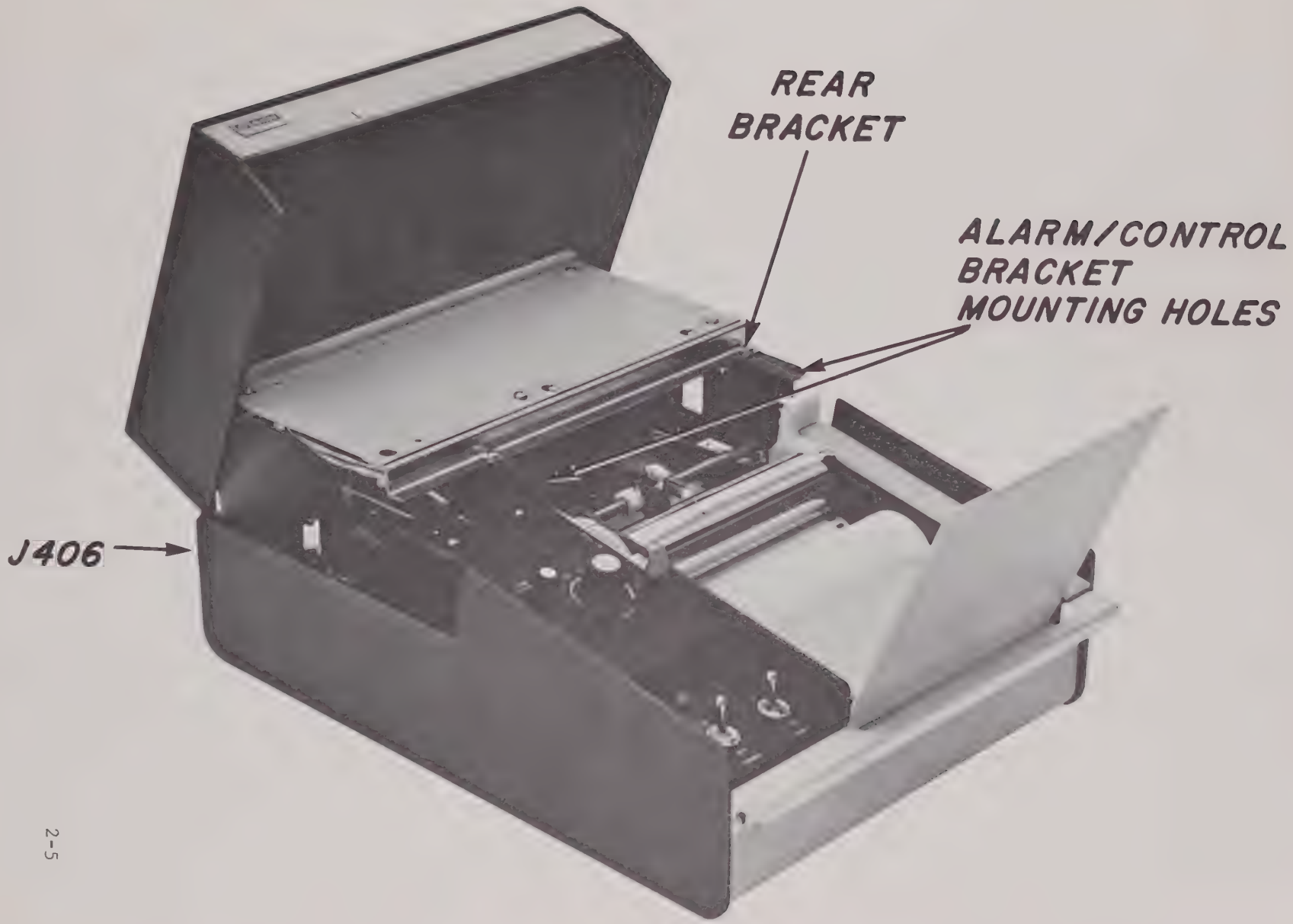


FIGURE 2-2

2.3.3 Installation of Accessory Power Supply

Partially disassemble the recorder following Steps 1 through 8 of paragraph 4.7 - Disassembly.

STEP 1. Mount transformer T301 adjacent to servo motor and mount power supply terminal board TB305 using holes provided in servo mounting plate. Mount connector J406 on the rear of the recorder adjacent to the fuse holder.

STEP 2. Refer to Wiring Diagram in Section 6 for correct wiring connections.

2.3.4 Installation of Event Markers

Left-hand and/or right-hand event marker assemblies are to be installed on the rear bracket.

STEP 1. Mount the event marker assembly and the assembly cover under the bracket, tightening 4-40 screws through the holes provided in the bracket and cover.

STEP 2. If the accessory power supply has not been installed in the recorder (for electric pen lift operation), follow the instructions in paragraph 2.3.3.

STEP 3. Connect event marker wiring in accordance with the Wiring Diagram in Section 6.

STEP 4. If not already in position, attach capillary tubing to the pen assembly. On the other end of the tubing is a pierce and prime unit.

STEP 5. Install ink cartridge clip(s). For left-hand event marker, see Figure 2-1; for right-hand event marker, see Figure 4-4.

STEP 6. Dress the capillary tubing through the chassis assembly to the ink cartridge clip.

STEP 7. As an aid when installing an ink cartridge, the indented end of the cartridge may be carefully pre-punched with a sharp object. This procedure is optional.

STEP 8. Insert the ink cartridge all the way onto the pierce and prime unit. Do not squeeze the cartridge; apply pressure only at the end opposite the end pierced by

2.3.4 Continued

the unit. Place the cartridge and pierce and prime unit in the clip. Attach capillary tubing to the pierce and prime unit.

STEP 9. With plastic tubing supplied, attach a pen filler to the pen tip and draw on the plunger until ink barely appears in the pen filler tubing. Remove the pen filler and its tubing.

SECTION 3
OPERATION

3.1 GENERAL

All operating controls and adjustments are located on the control panel or at the rear of the recorder. Both chart paper loading and ink cartridge installation are extremely simple procedures. Standard chart paper comes in rolls approximately 85 feet long. The number of feet remaining in the roll is marked at one foot intervals on the left-hand margin of the paper. A specially-formulated fast drying ink comes in cartridge form.

3.2 INSTALLATION OF CHART PAPER

STEP 1. Raise the pen lift-paper guide into its up position.

STEP 2. Push the release lever and rotate the RATIO control half way between stops to disengage gears.

STEP 3. Raise the platen and place a roll of chart paper on the flat portion of the paper chute so that the roll rests against the under side of the platen. Be sure that the round sprocket holes are at the left, and oblong holes are at the right.

STEP 4. Holding the roll in place, unwind about 8 inches of paper.

STEP 5. Feed the end of the paper under the sprocket drum. Turn the paper advance knob to pull the chart paper around the sprocket drum. Be sure the holes at either side of the chart paper are engaged with sprockets and that the paper is properly aligned.

STEP 6. Place the roll in the paper chute and lower the platen.

STEP 7. Lower the pen lift-paper guide.

STEP 8. Re-engage chart drive gears by rotating the RATIO control to a stop position.

3.2 Continued

STEP 9. Using the paper advance knob, advance the chart paper over the platen and feed the paper through the slot between the platen and the paper tear bar.

STEP 10. Attach the chart-weight clip to the end of the chart paper at its center.

3.3 INSTALLATION OF PEN ASSEMBLY AND INK CARTRIDGE- MAIN RECORDER PEN

STEP 1. As an aid when installing an ink cartridge, the indented end of the cartridge may be carefully prepunched with a sharp object. This procedure is optional.

STEP 2. Holding the pen assembly in its normal upright position (do not cover the vent tube with finger) insert the ink cartridge all the way onto the pen assembly. Do not squeeze the cartridge; apply pressure only at the end opposite the end pierced by the pen.

STEP 3. With plastic tubing supplied, attach a pen filler to the pen tip and draw on the plunger until ink barely appears in the tubing. Remove the pen filler and tubing.

STEP 4. Clip the pen assembly over the pen bearing. Be sure the guide pins engage the slot in the pen bearing. For correct pen alignment, push the pen assembly snug against the stop at the right-hand side of the pen bearing.

STEP 5. To remove the pen assembly (for replacement of the ink cartridge), simply slide the assembly off the left-hand end of the pen bearing.

3.4 INSTALLATION OF INK CARTRIDGES - EVENT MARKER PEN(S)

Follow Steps 7, 8, and 9 of paragraph 2.3.4.

3.5 PRIMARY POWER REQUIREMENTS

Recorders are shipped ready for operation from a primary power source of 115 or 230 vac, 60 or 50 Hz. Each recorder comes equipped with a 3-conductor power cable terminated with a standard power plug. A decal mounted on the rear of the recorder indicates power specifications for the recorder.

3.6 SIGNAL SOURCE CONNECTIONS

The red, black and silver binding posts at the rear of the recorder are used to connect signal voltages to be monitored. The red post is the high potential (+) terminal, the black post is the low potential (-) or signal ground terminal, and the silver post is the chassis ground terminal. These terminals should be used as required by the circuit configuration that produces the voltage to be monitored. Under standard polarity conditions, a positive-going signal applied to the red binding post will move the pen from left to right. See paragraph 4.9 for information on reversed polarity circuitry.

3.7 CONTROLS AND CALIBRATION ADJUSTMENTS

3.7.1 Power Control

The POWER switch (ON-OFF), located on the control panel, controls ac power to the recorder. In the ON position, the indicator lamp will light, the servo amplifier will operate and the pen will respond to input signals. Power is applied to the chart drive motor switch for energizing the chart drive motors. A short time will be required before the power supply voltages stabilize. In the OFF position, power is removed from the recorder.

3.7.2 Chart Drive Control

The CHART switch (HIGH,OFF,LOW), located on the control panel, controls power to the chart drive motor(s) when the POWER switch is ON. The chart drive motor on single-motor recorders is operated with this switch in the LOW position. A decal indicating chart speed(s) is located under the hinged top.

3.7.3 Span Control

The multiple span recorder has a 10-position rotary switch for selection of the desired span. Calibrated spans are 1, 2, 5, 10, 20, 50, 100, 200, 500 millivolts, and 1 volt. The variable attenuator (VAR ATTEN) control, located adjacent to the SPAN switch, operates switch S502 and variable resistor R505. Switch S502 is open in the CCW position (CAL) of the control; R505 provides continuous adjustment of input signal level from 100% to 20% of the full scale value selected by the SPAN switch when S502 is closed.

The span element on the fixed-span recorder may be exchanged for another element simply by withdrawing the unit and inserting the other element. If necessary, the procedures given in paragraph 4.8 may be followed to calibrate the recorder for the new span value.

3.7.4 Zero Adjustment

The ZERO control is located at the rear of the recorder. This control permits the operator to position the pen tip precisely at the desired zero position on the chart when the signal input terminals are shorted together. Full scale zero adjustment and one full scale width of zero suppression are provided on Series G-1000 recorders.

3.7.5 Calibration Adjustments

Damping (DAMP), gain (GAIN), and calibration (CAL)adjustments are located at the rear of the recorder and need no adjustment during normal operation.

3.8 MODES OF OPERATION

The various calibration adjustments of the recorder can be set as detailed in paragraph 4.8 to obtain the (1) left margin zero, (2) right margin zero, (3) displaced zero, or (4) suppressed zero mode of operation described below.

3.8.1 Left Margin Zero Mode

In the left margin zero mode of operation, the ZERO control is set so that the pen is positioned over the left margin of the chart paper when the signal input terminals are shorted. The pen is driven toward the right margin when a positive dc input signal voltage is applied. The adjustment can be set so that the right margin represents a voltage between 1 millivolt and 1 volt, depending on the span selected. The linear scale across the top of the recorder can be used to determine the value of each intermediate point on the chart paper when the left margin represents zero volts and the right margin represents some voltage between 1 millivolt and 1 volt.

3.8.2 Right Margin Zero Mode

In the right margin zero mode of operation, the ZERO control is set so that the pen is positioned over the right margin of the chart paper when the signal input terminals are shorted. The pen is driven toward the left margin when a negative dc input signal voltage is applied. The adjustment can be set so that the left margin represents a voltage between 1 millivolt and 1 volt, depending on the span selected. The linear scale across the top of the recorder can be used to determine the value of each intermediate point on the chart paper when the right margin represents zero volts and the left margin represents some voltage between 1 millivolt and 1 volt.

With reversed polarity circuitry (see paragraph 4.9), positive dc voltages will drive the pen to the left.

3.8.3 Displaced Zero Mode

The ZERO control can be set so that any point on the chart paper represents zero signal voltage. If any point except the left or right margin is used, the recorder is considered to be in a displaced zero mode of operation. In this mode, a positive input voltage drives the pen to the right and a negative input voltage drives the pen to the left. The VAR ATTEN control can be set so that the numerical (not algebraic) sum of the voltages is equal to the full scale voltage selected. The linear scale across the top of the recorder can be used to determine the value of each point on the chart paper.

EXAMPLE

If the calibration adjustments are set so that the pen comes to rest at the numeral 4 on a 0-10 scale with zero signal volts applied and at the numeral 10 with 6 millivolts applied, an input signal that drives the pen to the numeral 2 has a negative polarity and an amplitude of 2 millivolts.

3.8.4 Suppressed Zero Mode

In the suppressed zero mode, no point on the chart paper represents zero input signal. The left-and right-hand margins both represent voltages of a positive polarity that differ in amplitude. The difference in amplitude is determined by the setting of the CAL adjustment.

EXAMPLE

If the procedure in paragraphs 4.8.1 through 4.8.3 were followed so that the left margin represented zero signal and the right margin represented +50 millivolts, the procedure in paragraph 4.8.5 could be used to make the left margin represent +20 millivolts. This would automatically make the right margin represent +70 millivolts. Note that these procedures apply only to positive voltages and that the span remains the same (50 millivolts) but the end points are shifted (from zero to +20 millivolts and +50 to +70 millivolts) an equal amount in the same direction.

3.9 ELECTRICAL INSPECTION

If an electrical or mechanical failure occurs during this inspection, refer to paragraph 4.6.2 and perform a detailed physical inspection of the recorder.

STEP 1. Turn the POWER switch to OFF.

STEP 2. Turn the CHART switch to OFF.

STEP 3. Install a roll of the proper chart paper. See paragraph 3.2.

STEP 4. Install pen assembly and ink cartridge. See paragraph 3.3.

STEP 5. BE SURE THE RECORDER AND ANY AUXILIARY EQUIPMENT ARE CONNECTED TO EARTH GROUND. The ground wire of the 3-wire power cord and the silver binding post(s) (chassis ground) are internally connected. Thus, a 3-wire power cord automatically connects the recorder to earth ground when plugged into a grounded 3-wire power system. However, in the absence of this type of system, the recorder chassis and any auxiliary equipment MUST be connected to earth ground by means of an additional wire.

STEP 6. Short the red (+) and black (-) signal input terminals together.

STEP 7. On multiple span recorders, rotate the SPAN switch fully CW to the 1 volt position and the VAR ATTEN switch full CCW, to the CAL position, checking that both switches operate properly.

STEP 8. Connect the power cord to a proper source of power.

STEP 9. Turn the POWER switch to ON and observe that the indicator lamp is lit.

NOTE

If the indicator lamp does not light, check the fuse at the rear of the recorder and replace if necessary.

3.9 Continued

The pen will not respond instantaneously when the POWER switch is turned ON. Approximately 5 to 10 seconds are required for the amplifier voltages to stabilize and produce pen movement.

STEP 10. Rotate the ZERO control until the pen tip is aligned with the point on the chart paper that is to represent zero input signal.

STEP 11. Turn the CHART switch to LOW and observe that the chart paper moves smoothly. Repeat with the CHART switch turned to HIGH if two chart drive motors are installed.

NOTE

With very slow chart speeds, be sure sufficient time is allowed to determine that the paper actually is moving.

Test all positions of the RATIO control. DO NOT attempt to rotate the RATIO control unless power is ON.

STEP 12. On multiple span recorders, rotate the SPAN switch to any desired setting.

STEP 13. Remove the short from the signal input terminals. Connect a dc voltage between the same terminals corresponding to the SPAN switch setting, or with fixed-span recorders, to the voltage rating of the plug-in element. Observe that the pen moves to the point on the chart paper that represents the full scale voltage value.

STEP 14. Remove the dc voltage from the signal input terminals. Short these terminals and observe that the pen returns to the zero input signal position.

3.9 Continued

NOTE

The recorder is completely calibrated before shipment in accordance with the requirements specified. The calibration can be checked or changed as described in paragraph 4.8 of this manual.

STEP 15. Turn the CHART switch to OFF.

3.10 RECORDER OPERATION

3.10.1 Detailed Operating Instructions

STEP 1. Check supply of chart paper and ink.

STEP 2. Connect the power cord to an ac power source. BE SURE THE RECORDER IS PROPERLY GROUNDED. See Step 5, paragraph 3.9.

STEP 3. Turn the POWER switch ON. The pen will not respond instantaneously when the POWER switch is turned ON. Approximately 5 to 10 seconds are required for the amplifier voltages to stabilize and produce pen movement.

STEP 4. Short the red (+) and black (-) input terminals together.

STEP 5. Using the ZERO control, place the pen at the desired position.

STEP 6. On multiple span recorders, set the SPAN switch and the VAR ATTEN control in positions corresponding to the maximum voltage to be monitored.

STEP 7. On fixed-span recorders, check that the rating of the plug-in element corresponds to the maximum voltage to be monitored.

STEP 8. Remove the short across the input terminals and apply the input signal to be monitored.

STEP 9. Select the chart speed desired, placing the CHART switch in either the LOW or HIGH position (*) and rotating the RATIO control to the appropriate

(*) On single-motor recorders, the CHART switch is placed in the LOW position.

3.10.1 Continued

position. A table showing chart speeds vs RATIO control positions is located on the top shield under the hinged top.

STEP 10. To tear off chart paper, pull upward on the paper using the paper tear bar as a knife edge.

3.11 OPERATING REMARKS AND RECOMMENDATIONS

The presence of voltages of power-line frequency at the recorder input may result in impaired recorder performance. The following describes one method of reducing the effects of ac voltage at the input.

AC voltages may be picked up by wires connecting the input signal source to the recorder, especially if the signal source has high internal resistance. These undesirable ac voltages may be eliminated by using shielded wires to connect the input signal source to the recorder. If shielded wires are used, the shield should be grounded only at the ground terminal of the recorder. Grounding both ends of the shield can produce ground loops. Most low-resistance sources will not require shielding. Simple twisted-pair leads will usually be satisfactory.

Series G-1000 recorders may be operated with a steady dc potential of $\pm$200 volts maximum between chassis ground and the input signal.

SECTION 4
SERVICE AND MAINTENANCE

4.1 GENERAL

Service and maintenance of Series G-1000 recorders should be performed only by persons experienced in servicing electromechanical devices having transistorized circuitry. If no such person is available, the recorder should be sent to the factory, or to a factory representative, for service.

4.2 FIELD AND FACTORY SERVICE

Should it become necessary to return an instrument for service, please observe the following:

1. Remove pens, ink cartridges, chart paper, and power cord; do not send with equipment.

2. Rinse out any capillary tubing with water.

3. The original or another suitable container should be used and the recorder should be surrounded on all six sides by about 4 inches of packing material.

4. Recorders should be shipped by Railway Express, air freight, or motor freight, PREPAID, to the nearest Varian Associates Recorder Sales Representative, or to:

   Varian Associates
   611 Hansen Way
   Palo Alto, California 94303

   Attention: Recorder Division
   Service Manager

5. Each recorder should be accompanied by a full description of difficulties encountered, model and serial number of recorder, date of purchase, and name of representative from whom the recorder was purchased.

4.2 Continued

NOTE

Varian Associates has an established policy that equipment sent in for service will be completely checked in addition to correcting the cause of the malfunction.
Equipment shipped to the user will meet the specifications under which it was originally sold. When it appears that it will be unusually expensive to bring an out of warranty instrument up to specifications, the user will be contacted for specific instructions.

4.3 PREVENTIVE MAINTENANCE

4.3.1 Pens

Recorder pens must be kept clean for proper functioning. Inks are water-soluble. For cleaning, water should be forced through the pen system. Cold water is normally satisfactory, but if the pen is obstructed liquid detergent in warm water may be used and a piece of pen cleaning wire may be drawn through the pen system to dislodge the obstruction. The pen filler furnished with the recorder may be used as an aid in cleaning the pen. A small piece of plastic tubing installed between the pen filler and the pen tip may be used as a connection when drawing or feeding water through the pen. To assure maximum performance, pens should always be cleaned immediately after use.

4.3.2 Carriage Rod

To maintain smooth operation of the pen carriage, the carriage rod must be kept clean. Be sure to clean the rod if ink should accidentally be spilled onto it. Periodically, clean the carriage rod with a dry, lint-free cloth. DO NOT OIL THE ROD.

4.4 LUBRICATION

Only the servo motor in Series G-1000 recorders requires lubrication, at three month intervals. Remove the bottom screen from the recorder by following Steps 1 through 3 of paragraph 4.7 - Disassembly. Place one or two drops of motor oil (furnished with the recorder) in each of the red-painted holes in the servo motor. DO NOT OVER-LUBRICATE.

4.5 SEMICONDUCTOR TECHNIQUES AND PRECAUTIONS

Transistors, though similar in many ways to vacuum tubes, require different techniques in trouble shooting. The essential differences lie in the fact that transistors are inherently low-impedance devices operating on low voltages and small currents. Polarities depend on the type of transistor. PNP types normally require negative supply voltages. NPN types normally require positive supply voltages. Connecting the wrong voltage polarity is a sure way to break down the transistor junction.

If there does not appear to be a voltage drop between emitter and collector, it can be assumed that this junction is shorted. However, it is best to turn off all voltages in the system and make a resistance check before removing the transistor from the circuit. Care must be exercised in making this resistance check, since many ohmmeters use a sufficiently high voltage supply to their resistance bridge to burn out the transistor being checked.

When checking the base-to-emitter voltage, consider that this voltage should be greater than normal if the transistor is saturated and less than normal for a cut-off condition. A saturated transistor is characterized by a low emitter-to-collector voltage. The corresponding base-to-emitter voltage would be larger than normal. However, if the transistor appears to be saturated and the base-to-emitter voltage is lower than normal, or of the reverse polarity, a defective base-to-collector junction and excessive resultant leakage is indicated.

When making gain checks in transistor circuits, bear in mind that transistor voltage gains vary a great deal more than vacuum tube gains and that transistor failures are usually due to a junction breakdown, usually a "go" or "no go" situation. Another complication is the use of dc feedback for temperature stabilization. When one voltage in the circuit is abnormal, all circuit voltages may appear to be abnormal.

With all types of semiconductors, proper soldering techniques must be observed to avoid overheating the semiconductor junctions. To minimize excessive temperatures,(1) the semiconductor leads should be pre-tinned, (2) the terminal to which the lead is to be connected should be thoroughly cleaned, (3) a heat sink between the transistor or diode and the joint to be made should be used to draw heat away from the semiconductor, (4)a well-tinned soldering iron should be used, and (5) the connection should be made as quickly as possible. An alligator clip or a pair of long-nose pliers makes an excellent heat sink. The heat sink should be clamped to the lead as near to the diode or transistor as possible.

4.5 Continued

When applying signal voltages from a signal generator, it is essential that inputs be kept low in amplitude (under 1 v preferably) to avoid exceeding inverse voltage breakdown limits of the transistor junction. Since transsistors fail immediately when voltage breakdown values are exceeded, it is also essential that no transients be present in the transistor voltage supply.

A resistance check between transistor leads will indicate a defective transsistor when there has been a junction breakdown. A junction can break down between any two connections, without necessarily being shorted to the other element. A junction breakdown is the usual case with transistors that are not functioning properly. Care should be taken when using a multimeter in checking for shorts to avoid breaking down the transistor junction with excessive current. A 100-ohm resistor should be inserted in series with the multimeter leads and 100 ohms deducted from the multimeter reading.

The circuit between any two elements of a transistor is the equivalent of a diode. Resistance checks made with the transistor out of the circuit will show a very high resistance in one direction, usually appearing as an open when measured with a multimeter, and much lower resistance in the reverse direction.

To test a transistor still connected to the circuit, check voltages at base, emitter, and collector connections.

Voltage measurements in a transistor circuit can be misleading. If a VTVM with a grounded connection is used, and voltages are measured from ground, there will be very little difference between the base and emitter readings. The base-to-emitter voltage is usually only a few tenths of a volt. This voltage is best measured directly by a multimeter or by a VTVM that is battery powered and has no power connection to the ground.

4.6 TROUBLESHOOTING

4.6.1 General

If the recorder does not function properly, proceed as follows:

Read Section 3 of this manual carefully. Determine that (1) the chart paper and ink were properly installed, (2) the recorder is connected to a proper source of primary power, (3) the signal inputs are properly connected to the recorder, and (4) the operating controls are in appropriate positions. Schematics and Wiring Diagram in Section 6 can be used as guides while trouble shooting.

4.6.2 Physical Inspection

Disassemble the recorder following the procedure give in paragraph 4.7. Thoroughly inspect the recorder. Among the points to be covered are the following:

a. Check that all assemblies and components are securely mounted.

b. Check that all connections to terminal boards, connectors, etc., are securely fastened.

c. Check that gears operate properly. A minimal backlash should exist between gears and idlers.

d. Check pen drive cabling for smooth operation.

4.6.3 Troubleshooting Chart

Following is a list of symptoms and possible causes of recorder malfunction:

TABLE III

Troubleshooting Chart

Symptom	Possible Cause
Recorder fails to operate	Power cord not connected. Fuse open.
Chart paper does not advance	RATIO control gears disengaged. Fuse open.
Intermittent chart paper advance	Improper gear operation.
Pen moves to extreme limit of travel; servo motor continues to operate.	Chopper defective. Input circuit open.
Large dead band, sluggish operation	Low amplifier gain. Stray ac pickup. Excessive source resistance. Low line voltage. Chopper defective. Bind in mechanical system. Excessive drive cable tension. Zener diodes defective.
Nonuniform pen velocity	Bind in mechanical system (pen carriage binding on rod). Excessive drive cable slack. Chopper defective.
Pen oscillates at any position of DAMP control.	Excessive amplifier gain. Dirty potentiometer. Open damping control.

4.6.3 Continued

Symptom	Possible Cause
Repeated pen "jitter" at same point on chart.	Dirty or worn feedback potentiometer.
Intermittent pen oscillation at various points on chart	Power line transients. Loose connection of signal cable.
Low or zero gain	Defective transistor.
Steady pen deflection to right or left	Chopper defective (bad contacts). Input circuit open.
No servo control; no signal response	Chopper defective (open winding).
Erratic pen movement	Feedback potentiometer defective. Power supply capacitors defective.
Loss of reference or amplifier supply voltage	Zener diodes defective.
Full span sweep across chart is curved or irregular	Bind in mechanical system. Shorted potentiometer windings.
Loss of calibration	Zener diodes defective.

4.7 DISASSEMBLY

To disassemble the recorder for amplifier servicing, restringing pen drive cable, potentiometer replacement, or installation of a second chart drive motor, follow Steps 1 through 8 of this procedure. For power supply servicing, follow all steps of this procedure. Be sure the power cord and signal leads are disconnected.

STEP 1. To remove the case top (a) tilt top upward; (b)grasp it at the right-hand rear edge and spring the side piece out to the right, disengaging it from the hinge pin; (c) move it to the left, and disengage from the left-hand hinge pin.

STEP 2. Turn the recorder upside down while holding the platen down.

STEP 3. Refer to Figure 4-1 and 4-2; remove the 12 screws indicated by numbers 1 through 12. Remove the bottom screen. (It is not necessary to remove the screws in the recorder feet).

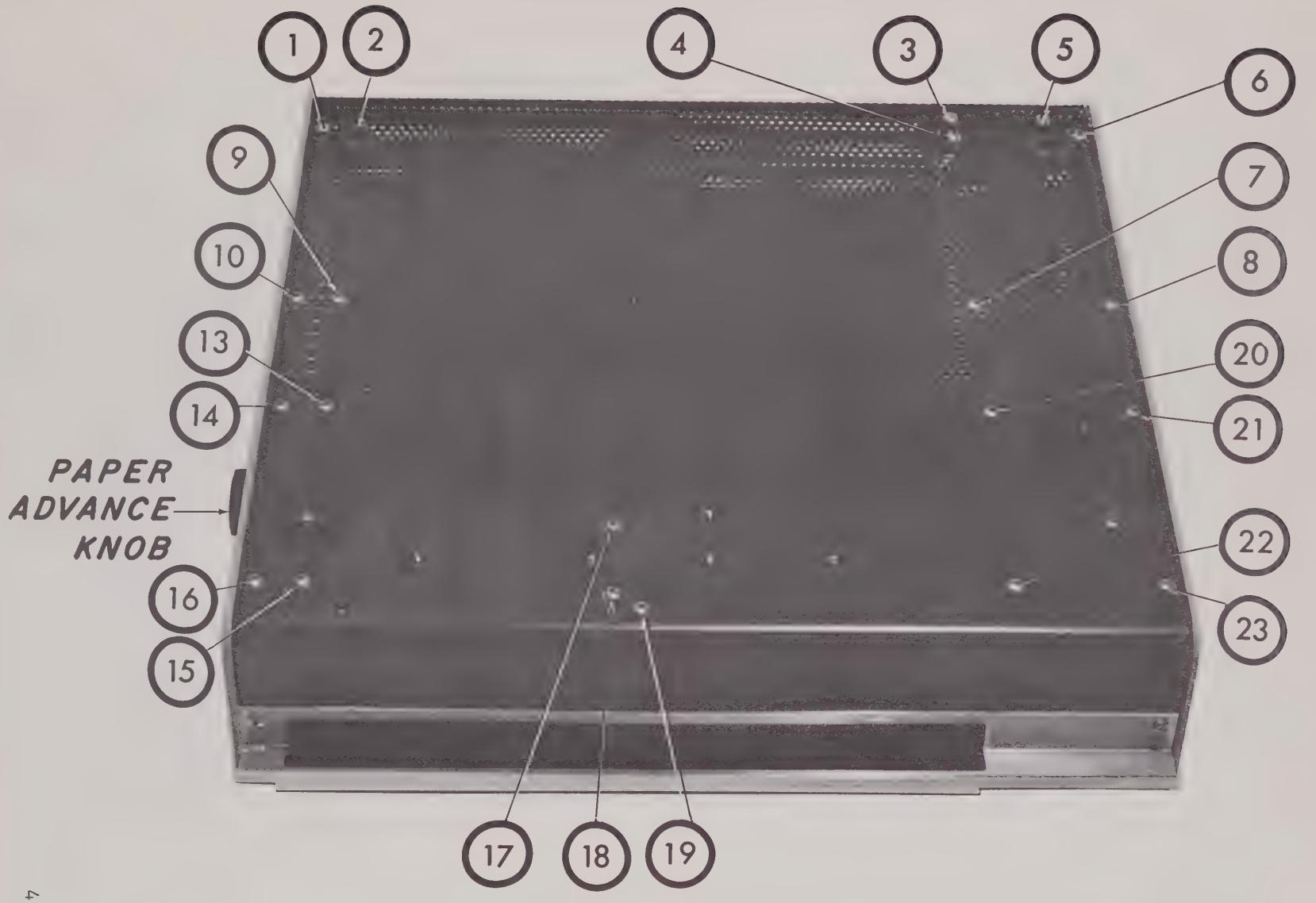


FIGURE 4-1

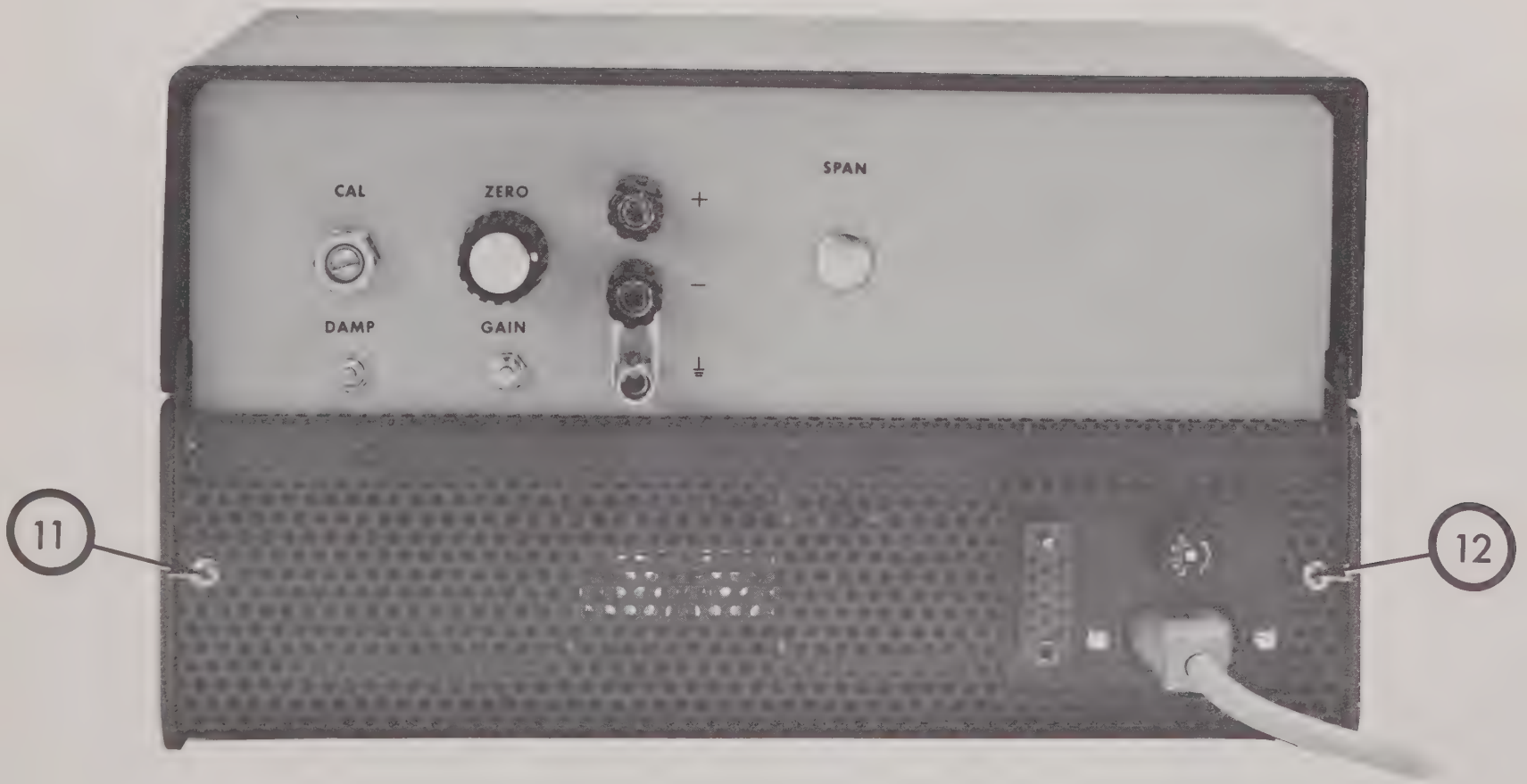


FIGURE 4-2

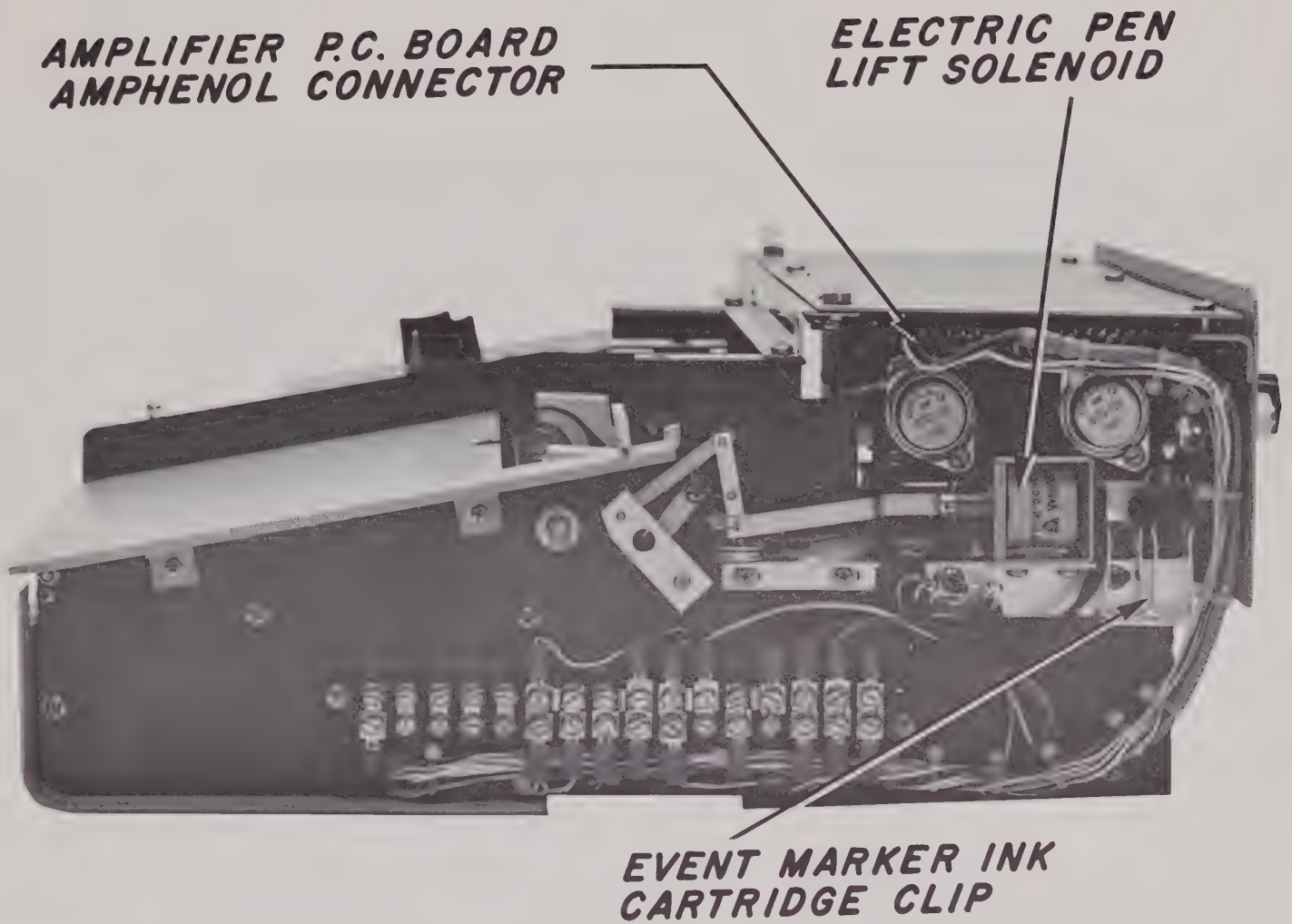

AMPLIFIER P.C. BOARD
AMPHENOL CONNECTOR
ELECTRIC PEN
LIFT SOLENOID
EVENT MARKER INK
CARTRIDGE CLIP

FIGURE 4-4

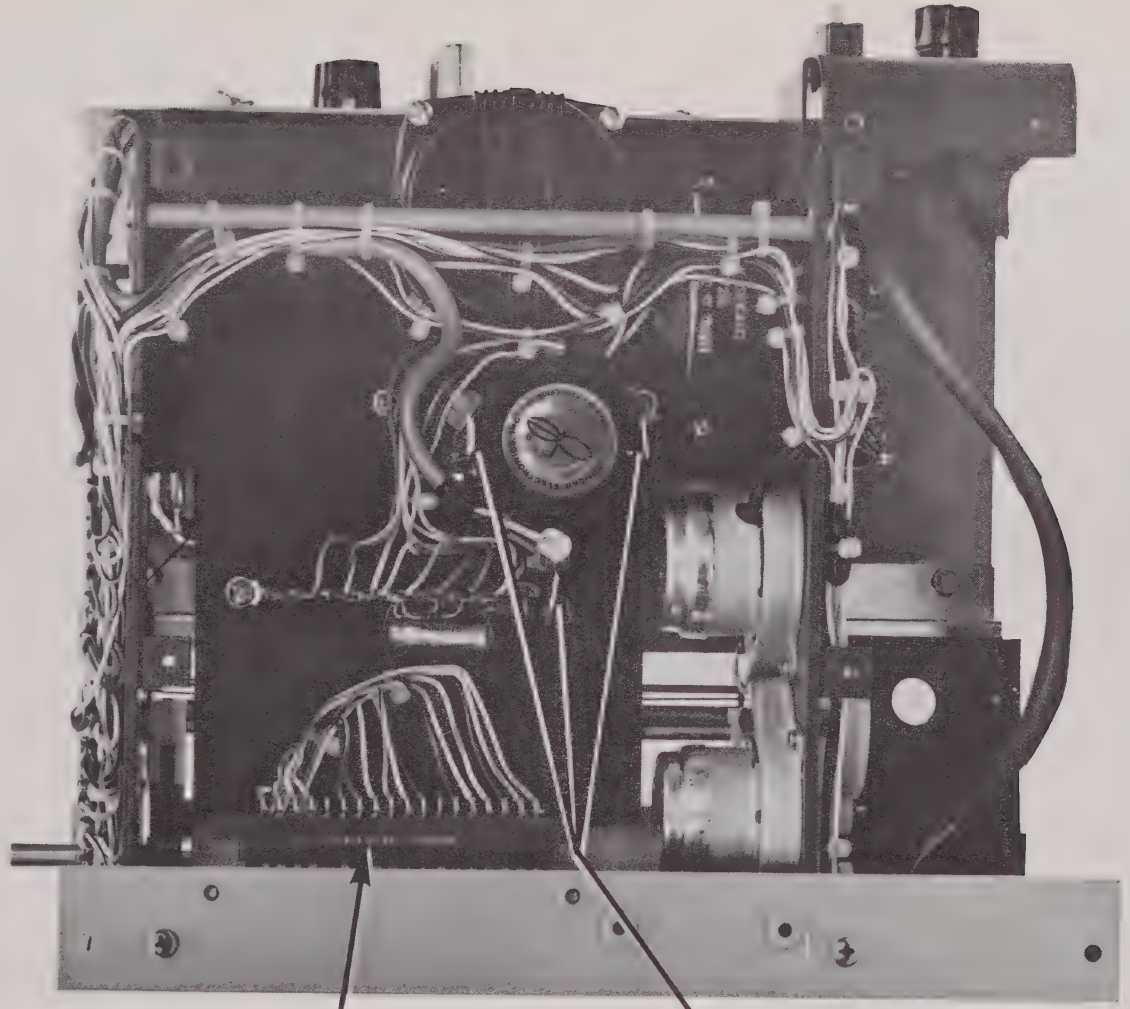


FIGURE 4-5

4.7 Continued

STEP 4. Turn the recorder over, with the rear facing the technician.

STEP 5. Refer to Figure 4-3 and remove the 2 screws indicated along the bottom of the input panel.

STEP 6. Remove the two screws at either end of the rear bracket. See Figure 2-2.

STEP 7. Unplug the Amphenol connector from the amplifier printed circuit board. See Figure 4-4.

STEP 8. The entire amplifier assembly can now be lifted away from the recorder chassis.

W A R N I N G

USE EXTREME CAUTION WHILE
PERFORMING MAINTENANCE ON
A DISASSEMBLED RECORDER,
SINCE PRIMARY POWER SWITCH
TERMINALS ARE EXPOSED.

STEP 9. Turn the recorder upside down while holding the platen down.

STEP 10. Refer to Figure 4-1 and remove the 11 screws indicated in the power supply assembly (numbers 13 through 23).

STEP 11. Loosen two 6-32 set screws in the paper advance knob and remove the knob. Both side panels can now be removed.

STEP 12. Unplug the Amphenol connector from the power supply printed circuit board. See Figure 4-5. The power supply assembly is now available for servicing.

STEP 13. To reassemble the recorder, reverse the above procedure.

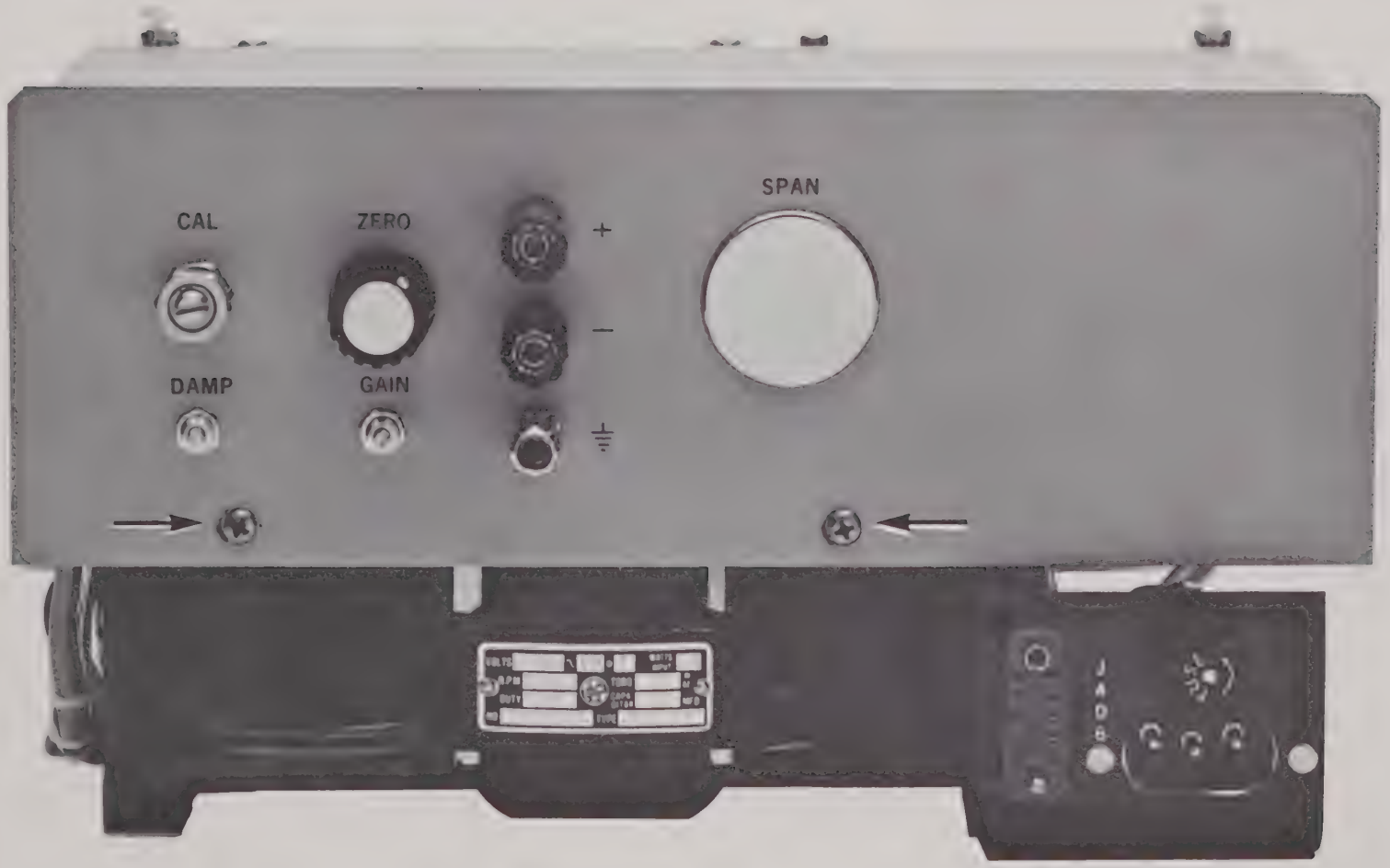


FIGURE 4-3

4.8 CALIBRATION

Series G-1000 recorders are completely calibrated before shipment. This procedure can be used to change the operating characteristics of the recorder or to restore the original characteristics after service.

STEP 1. Check that the recorder is supplied with chart paper, pen, and ink. If necessary refer to Section 3 and replenish the paper and ink.

STEP 2. Connect the recorder to a proper source of power and turn the POWER switch to ON.

STEP 3. Set the CHART switch and RATIO control so that the chart paper is passing through the recorder at the highest rate of speed possible, but not faster than 1 inch per minute.

4.8.1 Zero Adjustment

STEP 1. Short the input terminals together.

STEP 2. On multiple span recorders, rotate the VAR ATTEN control fully CCW to the CAL position.

STEP 3. Set the ZERO control so that the pen is in exact alignment with the desired zero position on the chart paper. With standard polarity circuitry, this is usually near the left-hand margin. With reversed polarity (see paragraph 4.9), the zero position is usually near the right-hand margin of the chart paper.

4.8.2 Calibrate Adjustment

The CAL adjustment can be set as follows to provide full scale deflection of the pen assembly with a maximum input signal corresponding to the setting of the SPAN switch, or the voltage value of the plug-in span element.

STEP 1. Short the input terminals together and note that the pen is aligned with the zero position on the chart. Remove the short.

NOTE

If necessary, perform the Zero Adjustment procedure given in paragraph 4.8.1.

STEP 2. On multiple span recorders, set the Span switch at any desired position.

4.8.2 Continued

STEP 3. Connect a fixed dc voltage between the input terminals corresponding to the SPAN switch setting (or to the voltage value of the plug-in span element).

STEP 4. Rotate the CAL adjustment so that the pen is in exact alignment with the desired full scale position on the chart.

STEP 5. Disconnect the fixed dc voltage from the input terminals.

4.8.3 Gain and Damping Adjustments

The GAIN and DAMP adjustments of the recorder can be set as follows:

STEP 1. Short the signal input terminals together. Set the ZERO control so that the pen comes to rest at the center of the chart paper.

STEP 2. Turn the DAMP adjustment fully CW (maximum damping).

STEP 3. Remove the short from the signal input terminals and connect a dc voltage of an amplitude that will drive the pen less than half scale.

STEP 4. Short the input terminals and allow the pen to make a short trace on the paper.

STEP 5. Reverse the polarity of the voltage applied in Step 3; then momentarily remove the short connected in Step 4, allowing the pen to make a second short trace.

STEP 6. Determine the horizontal distance between the traces made in Steps 4 and 5. If it is greater than 20% of one small division of the chart paper (0.2% full scale), the GAIN adjustment should be turned slightly clockwise, and Steps 3 through 5 should be repeated.

STEP 7. Disconnect the short from the signal input terminals and observe the trace made by the pen. Note that the pen does not overshoot the point on the chart paper at which it finally comes to rest.

STEP 8. Turn the DAMP adjustment slightly CCW, reconnect the short across the input terminals, then remove it again.

4.8.3 Continued

STEP 9. Observe the trace made on the chart paper. Repeat Step 8 until there is evidence of a small amount of overshoot; then, turn the DAMP adjustment slightly CW.

NOTE

The ideal trace (critical damping) forms a 90-degree angle where it changes from a horizontal to a vertical direction. Do not turn the DAMP adjustment so far as to round off this "corner."

STEP 10. Make the zero adjustment described in paragraph 4.8.1 and check the calibrate adjustment described in paragraph 4.8.2.

NOTE

If it is necessary to reset the CAL adjustment, repeat Steps 1 through 10, paragraph 4.8.3.

4.8.4 Displaced Zero Operation

The ZERO adjustment is set according to the procedure given in paragraph 4.8.1. For displaced zero operation, the zero position on the chart is other than the left-hand or right-hand margin.

4.8.5 Suppressed Zero Operation

The following calibration procedure can be used when suppressed zero operation is desired:

STEP 1. Follow the procedures given in paragraph 4.8.1 through 4.8.3.

STEP 2. Select an appropriate position of the SPAN switch, or insert a plug-in span element of appropriate voltage rating.

STEP 3. Connect to the signal input terminals a fixed dc voltage of the value to be represented by the zero position on the chart paper.

4.8.5 Continued

NOTE

Observe polarity of input terminals. This voltage must not exceed the full scale value of the span selected.

STEP 4. Set the ZERO control so that the pen is in exact alignment with the desired zero position on the chart paper.

STEP 5. Disconnect the fixed dc voltage from the input terminals.

4.9 REVERSED POLARITY CIRCUITRY

Optional reversed polarity circuitry permits the reversal of zero position on the chart (example: left-hand to right-hand margin) and reverses the direction of pen travel with increasing positive signals. Modification of a recorder from standard to reversed polarity circuitry should be performed at the factory.

4.10 RESTRINGING PEN DRIVE CABLE

Remove the pen and partially disassemble the recorder following Steps 1 through 8 of paragraph 4.7 - Disassembly. The technician will now be facing the rear of the recorder. Remove old cable, if necessary. Refer to Figure 4-6 which shows cable correctly strung.

STEP 1. Rotate the potentiometer sheave fully CCW. Be sure the slot in the sheave is perpendicular to the pen rod.

STEP 2. Using the replacement cable, insert one end through the slot in the sheave closest to the pen rod.

STEP 3. Wrap the cable 1/2 turn CCW around the spring-loaded idler pulley at the left of the potentiometer. Pull the cable taut enough so the pulley turns through a 120^{o} arc. Check that the cable end in the sheave is about 1/16" lower than the cable on the idler pulley.

STEP 4. Wrap 1/2 turn CW around the stationery idler pulley at the rear of the recorder.

STEP 5. Wrap 1 turn CW around the servo motor sheave.

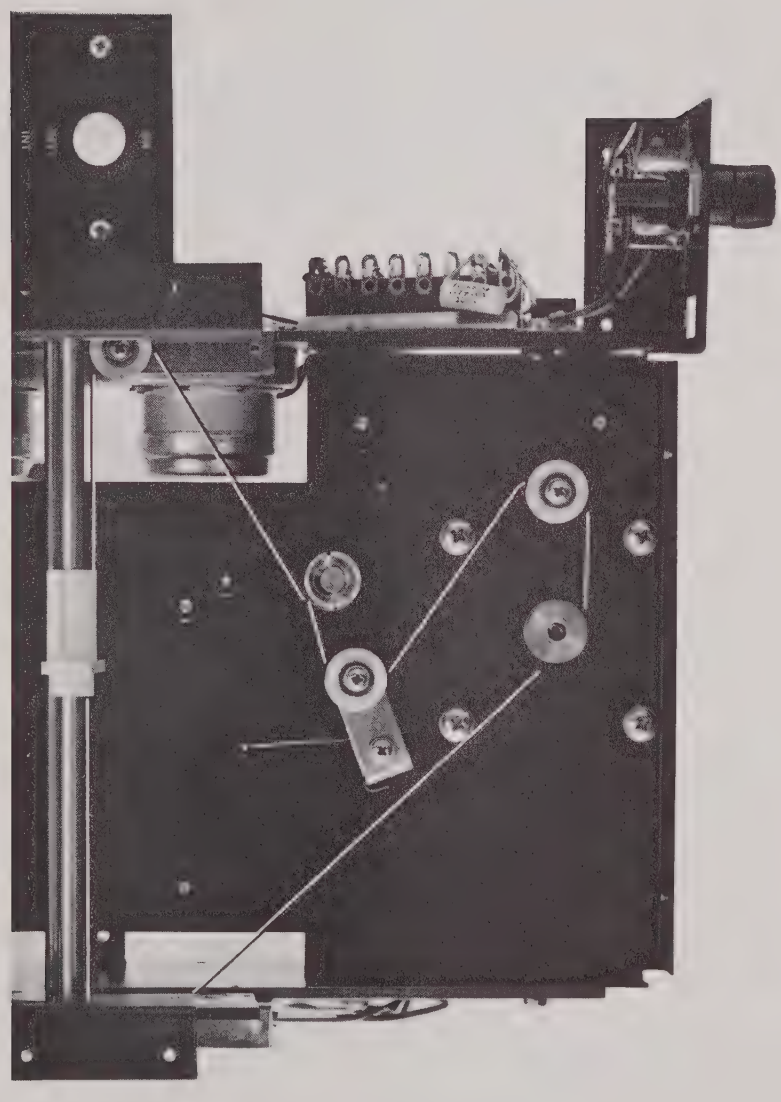


FIGURE 4-6

4.10 Continued

STEP 6. Wrap 1/2 turn CW around the front pulley on the bracket at the left-hand side of the recorder.

STEP 7. Slide the pen bearing to its extreme right-hand limit of travel.

STEP 8. Insert the cable through the slot in the pen bearing.

STEP 9. Loop the cable under the corner of the pen bearing and back through the slot. Repeat the loop to obtain two loops.

STEP 10. Wrap the cable 1/2 turn CW around the front pulley on the bracket at the right-hand side of the recorder.

STEP 11. Holding the cable taut at the front of the potentiometer sheave, rotate the potentiometer CW allowing the cable to wrap around the sheave until the pen bearing reaches its full left-hand limit of travel. The cable must be aligned progressively UP the sheave.

STEP 12. Insert the cable end through the slot in the potentiometer sheave and push the end down until the cable end is 1/16 inch above the cable going to the idler pulley. This is the same slot used for the beginning end of the cable in Step 2.

STEP 13. Move the pen bearing from left to right and check that at approximately 1-1/2 inches from the left-hand limit the cables intertwine and do not ride over each other. Move the pen bearing back and forth to assure that the stringing system is operating smoothly.

STEP 14. Proceed to paragraph 4.10.1 for potentiometer phasing procedure.

4.10.1 Potentiometer Phasing

STEP 1. Move the pen bearing to the extreme right-hand limit of travel.

NOTE

"Right-hand" as meant facing the rear of the recorder with the recorder upright.

STEP 2. Remove the amplifier connector P304 and connect the leads of an ohmmeter (reading on lowest resistance scale) between pins U and V.

NOTE

Do not contact pin T.

If the ohmmeter reading is 125 ±10 ohms, the potentiometer is properly phased. If not, proceed to Step 3.

STEP 3. Loosen the set screw in the potentiometer sheave, using a 4-40 Allen wrench.

STEP 4. Holding the pen bearing in position (extreme right-hand limit), rotate the potentiometer shaft until the ohmmeter reads 125 ±10 ohms.

STEP 5. Tighten the set screw in the potentiometer sheave.

STEP 6. If, after the recorder has been placed in operation, the ZERO control does not permit full scale zero adjustment, the potentiometer must be rephased, as above described. If less than full scale zero adjustment is obtained, the potentiometer resistance must be greater than 125 ohms.

4.11 CHART DRIVE MOTOR REPLACEMENT

STEP 1. Partially disassemble the recorder, following Steps 1 through 8 of paragraph 4.7.

STEP 2. Disconnect the electrical leads, of the motor to be replaced, from its terminal board mounted on the left-hand side frame. See Figure 2-1.

STEP 3. Loosen the set screw in the motor pinion gear and remove the gear from the motor shaft.

4.11 Continued

STEP 4. Remove the 4-40 screws and lockwashers which fasten the motor to the side frame, and remove the motor.

STEP 5. Align the motor to be installed with the holes in the side frame.

STEP 6. Fasten the motor in place using the two 4-40 screws and lockwashers. Do not tighten.

STEP 7. Place the chart drive motor pinion gear onto the motor shaft. Tighten the set screw in the gear onto the flat side of the shaft.

STEP 8. Adjust the motor position so that the motor gear engages the idler. Be sure that minimal backlash exists between the motor gear and idler, i.e., slight mechanical oscillation should exist between the gears.

STEP 9. Tighten the motor screws.

STEP 10. Place the motor electrical leads through the slot in the bottom of the left-hand side frame. Connect the leads to the terminal board exactly as wired in Step 2, above.

STEP 11. Reassemble the recorder, reversing the procedure of Step 1.

4.12 POTENTIOMETER REPLACEMENT

Partially disassemble the recorder following Steps 1 through 8 of paragraph 4.7 - Disassembly. The technician will now be facing the rear of the recorder.

STEP 1. Move the pen bearing to its extreme right-hand limit of travel.

STEP 2. Loosen the set screw in the potentiometer sheave using a 4-40 Allen wrench.

STEP 3. Push the sheave down onto the servo mounting plate and tape the sheave in place with masking tape. The stringing should not be disturbed.

STEP 4. Turn the recorder upside down. See Figure 4-5.

4.12 Continued

STEP 5. Unsolder the leads and capacitor from the potentiometer, noting the relative locations of the leads on the potentiometer terminals.

STEP 6. Remove the three 4-40 screws and potentiometer clamps and remove the potentiometer.

STEP 7. Rotate the shaft of the new potentiometer fully CCW.

STEP 8. Position the potentiometer so the terminals face the front of the recorder and insert the potentiometer shaft into the sheave. Replace the three 4-40 screws and potentiometer clamps.

STEP 9. Solder the leads and capacitor to the potentiometer terminals.

STEP 10. Turn the recorder over.

STEP 11. Remove the masking tape from the potentiometer sheave. Raise the sheave until the cable from the sheave to the right-hand pulley is horizontal.

STEP 12. Proceed to Step 2 of paragraph 4.10.1 and phase the potentiometer.

SECTION 5
PARTS LISTS

This section consists of four tables:

Table 5-1 CHART DRIVE MOTORS AND MOTOR ASSEMBLIES

Table 5-2 ELECTRICAL PARTS LISTS - BASIC RECORDERS

- Recorder Subassembly
- Servo Mounting Plate Assembly
- Parallel T Filter Assembly
- Amplifier Subassembly
- Input Assembly
- Output Assembly
- Amplifier P.C. Board Assembly
- Power Supply Assembly
- Reference Supply P.C. Board Assembly
- Power Supply P.C. Board Assembly
- Switch Assembly

Table 5-3 ELECTRICAL PARTS LISTS - ACCESSORIES AND OPTIONS

- Electric Pen Lift Kit
- Accessory Power Supply Kit

Table 5-4 REPLACEMENT PARTS, SUPPLIES, AND KITS

TABLE 5-1

CHART DRIVE MOTORS AND MOTOR ASSEMBLIES

60 Hz Chart Motor Assembly No.	60 Hz Motor No.	50 Hz Chart Motor Assembly No.	50 Hz Motor No.	Four Chart Speed Assembly at Ratio 1		Motor Speed (rpm)
C972-141-01	B941-733-01	C972-141-40	B941-733-13	1/12	inch/hour	1/240
C972-141-02	B941-733-02	C972-141-41	B941-733-14	1/6	inch/hour	1/120
C972-141-03	B941-733-03	C972-141-42	B941-733-15	1/3	inch/hour	1/60
C972-141-04	B941-733-04	C972-141-43	B941-733-16	1/2	inch/hour	1/40
C972-141-05	B941-733-12	C972-141-44	B941-733-24	2/3	inch/hour	1/30
C972-141-06	B941-733-06	C972-141-45	B941-733-18	2	inch/hour	1/10
C972-141-07	B941-733-07	C972-141-46	B941-733-19	2-1/2	inch/hour	1/8
C972-141-08	B941-733-09	C972-141-47	B941-733-21	4	inch/hour	1/5
C972-141-09	B941-734-46	C972-141-48	B941-734-48	5	inch/hour	1/4
C972-141-16	B941-733-35	C972-141-55	B941-733-36	7-1/2	inch/hour	3/8
C972-141-10	B941-734-47	C972-141-49	B941-734-49	10	inch/hour	1/2
C972-141-11	B941-733-33	C972-141-50	B941-733-34	1/4	inch/minute	3/4
C972-141-12	B941-734-31	C972-141-51	B941-734-39	1/3	inch/minute	1
C972-141-13	B941-734-32	C972-141-52	B941-734-40	2/3	inch/minute	2
C972-141-14	B941-734-33	C972-141-53	B941-734-41	1	inch/minute	3
C972-141-15	B941-734-35	C972-141-54	B941-734-43	2	inch/minute	6

TABLE 5-2 ELECTRICAL PARTS LISTS - BASIC RECORDERS

Schematic Reference	Description	Varian Part Number
Recorder Subassembly - Part No. E972-370		
DS301	Lamp, neon, amber lens	67-499-961
F301	Fuse	See par. 2.2
S301	Power switch,toggle, DPST	71-139-990
S302	Chart drive switch,toggle DPDT	71-149-960
Servo Mounting Plate Assembly - Part No. D-972-340		
B304	Motor, servo	943-364
C304	Capacitor, 0.5 mfd, 200 v	907-529-05
R301	Potentiometer, feedback	906-549
Parallel T Filter Assembly - Part No. C972-541		
C701	Capacitor, 0.25 mfd.,200 v	907-527-02
C702	Capacitor, 0.25 mfd.,200 v	907-527-02
C703	Capacitor, 0.5 mfd, 200 v	907-527-01
R701	Resistor, 11.3K, 1% (60 Hz only)	31-605-113
R701	Resistor, 13.7K, 1% (50 Hz only)	31-605-137
R702	Resistor, 11.3K, 1% (60 Hz only)	31-605-113
R702	Resistor, 13.7K, 1% (50 Hz only)	31-605-137
R703	Resistor, 5.62K, 1% (60 Hz only)	31-604-562
R703	Resistor, 6.81K, 1% (50 Hz only)	31-604-681
Amplifier Subassembly, Right Hand - Part No. D972-365		
C401	Capacitor, 0.022 mfd, 200 v	41-724-955
CH101	Contact Modulator	905-523
J401	Input terminal, red	51-799-942
J402	Input terminal, black	51-799-941
J403	Input terminal, silver (uninsulated)	51-799-984

TABLE 5-2 Continued

Schematic Reference	Description	Varian Part Number
R401	Resistor, 15 K, 1/4w, 5%	32-301-515
R402	Potentiometer, 25K, Gain	972-523-02
R403	Potentiometer, 1.5K, Cal	37-586-415
R404	Potentiometer, 5K, Zero	971-570
R405	Potentiometer, 100K, Damp	972-523-03
Input Assembly - Part No. D972-478		
T101	Transformer, input	907-753
Output Assembly - Part No. D972-477		
C118	Capacitor, 0.5 mfd, 200 v	907-529-05
C119	Capacitor, 0.5 mfd, 200 v	907-529-05
Q109	Transistor, DTG-110	62-989-750
Q110	Transistor, DTG-110	62-989-750
T102	Transformer, output	972-070
Amplifier P.C Board Assembly, R.H. Channel - Part No. D972-096		
C104	Capacitor, 150 mfd, 3 V	41-506-227
C105	Capacitor, 35 mfd, 25 V	41-506-000
C106	Capacitor, 0.022 mfd, 200 V	41-724-955
C107	Capacitor, 100 mfd, 12 V	41-506-253
C108	Capacitor, 35 mfd, 25 V	41-506-000
C109	Capacitor, 10 mfd, 15 V	41-506-239
C110	Capacitor, 100 mfd, 3 V	41-506-002
C111	Capacitor, 0.033 mfd, 200 V	41-724-973
C112	Capacitor, 25 mfd, 12 V	41-506-219
C113	Capacitor, 100 mfd, 12 V	41-506-253
C114	Capacitor, 10 mfd, 25 V	41-506-244
C115	Capacitor, 10 mfd, 25 V	41-506-244
C116	Capacitor, 10 mfd, 25 V	41-506-244
C117	Capacitor, 0.056 mfd, 200 V	907-527-08
C120	Capacitor, 5 mfd, 12 V	41-506-236
C121	Capacitor, 5 mfd, 12 V	41-506-236
CR101	Diode, 1N457A	66-300-457
CR102	Diode, 1N457A	66-300-457

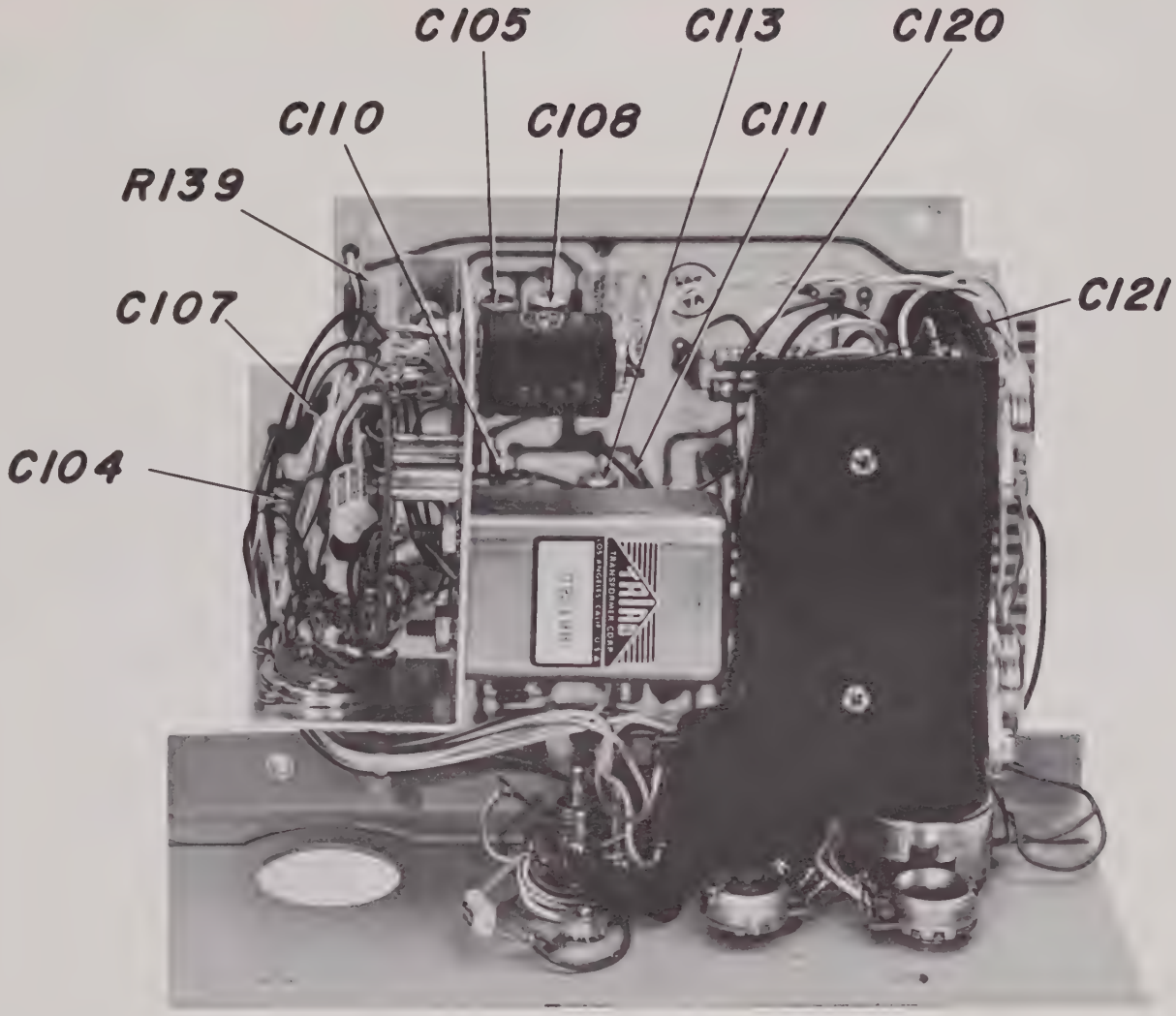


FIGURE 5-1 AMPLIFIER

Table 5-2 Continued

Schematic Reference	Description	Varian Part Number
Q101	Transistor,Special	943-384
Q102	Transistor, 2N3906	62-903-906
Q103	Transistor, 2N3391A	62-003-391
Q104	Transistor, 2N3906	62-903-906
Q105	Transistor, 2N3391A	62-003-391
Q106	Transistor, 2N3391A	62-003-391
Q107	Transistor, 2N3904	62-903-904
Q108	Transistor, 2N3904	62-903-904
R104	Resistor, 18K, 1/4w, 5%	32-301-518
R105	Resistor, 180K, 1/4w, 5%	32-301-618
R106	Resistor, 100 ohms, 1/4w, 5%	32-301-310
R107	Resistor, 22K, 1/4w, 5%	32-301-522
R108	Resistor, 10K, 1/4w, 5%	32-301-510
R109	Resistor, 150 ohms, 1/4w, 5%	32-301-315
R110	Resistor, 18K, 1/4w, 5%	32-301-518
R111	Resistor, 2.2K, 1/4w, 5%	32-301-422
R112	Resistor, 18K, 1/4w, 5%	32-301-518
R113	Resistor, 270 ohms, 1/4w, 5%	32-301-327
R114	Resistor, 27K, 1/4w, 5%	32-301-527
R115	Resistor, 15K, 1/4w, 5%	32-301-515
R116	Resistor, 270 ohms, 1/4w,5%	32-301-327
R117	Resistor, 22K, 1/4w, 5%	32-301-522
R118	Resistor, 10K, 1/4w, 5%	32-301-510
R119	Resistor, 10K, 1/4w, 5%	32-301-510
R120	Resistor, 2.7K,1/4w, 5%	32-301-427
R121	Resistor, 120 ohms, 1/4w, 5%	32-301-312
R122	Resistor, 1.8K, 1/4w,5%	32-301-418
R123	Resistor, 120 ohms, 1/4w,5%	32-301-312
R124	Resistor, 2.7K,1/4w,5%	32-301-427
R125	Resistor, 4.7K, 1/4w, 5%	32-301-447
R126	Resistor, 1.5K, 1/2w,5%	32-201-415
R127	Resistor, 4.7K, 1/4w, 5%	32-301-447
R130	Resistor, 120 ohms, 1/4w, 5%	32-301-312
R131	Resistor, 120 ohms, 1/4w,5%	32-301-312
R132	Resistor, 8.2K, 1/4w, 5%	32-301-482
R133	Resistor, 220 ohms, 1/4w, 5%	32-301-322
R134	Resistor, 220 ohms, 1/4w, 5%	32-301-322
R135	Resistor, 8.2K, 1/4w, 5%	32-301-482
R136	Resistor, 680 ohms, 1w, 5%	33-301-368
R137	Resistor, 2 ohms, 1/2w, 5%	32-201-102
R139	Resistor, 715K, 1%	31-606-715
R140	Resistor, 2 ohms, 1/2w, 5%	32-201-102
R141	Resistor, 2 ohms, 1/2w, 5%	32-201-102

TABLE 5-2 Continued

Schematic Reference	Description	Varian Part Number
R142	Resistor, 3.9K, 1/4w, 5%	32-301-439
R143	Resistor, 33K, 1/4w 5%	32-301-533
R144	Resistor, 100K, 1%	31-606-100
R145	Resistor, 3.01K, 1%	31-224-301
Power Supply Assembly - Part No. C972-623		
L201	Choke, Tranex No. 1-0227 (230 V only)	972-092
R213	Resistor, 350 ohms, 5w,5% (230 V only)	35-289-335
T201	Transformer, power	972-077
Reference Supply P.C. Board Assembly - Part No. A971-724		
C206	Capacitor, 200 mfd, 10V	41-506-225
CR201	Diode, Zener, LMZX22A	66-393-402
CR202	Diode, Zener, 1N936	66-300-936
R203	Resistor, 820 ohms, 1w, 5%	33-301-382
R204	Resistor, 1.5K, 1/4w, 5%	32-301-415
Power Supply P.C. Board Assembly - Part No. D972-089		
C201	Capacitor, 2 mfd, 200 V,	41-729-580
C202	Capacitor, 100 mfd, 50 V	41-506-229
C203	Capacitor, 500 mfd, 50 V	41-508-881
C204	Capacitor, 100 mfd, 50 V	41-506-229
C205	Capacitor, 100 mfd, 50 V	41-506-229
C207	Capacitor, 50 mfd, 25 V	41-506-256
C208	Capacitor, 50 mfd, 25 V	41-506-256
C209	Capacitor, 0.5 mfd, 200 V (60 Hz only)	41-729-541
C209	Capacitor, 1 mfd, 200 V (50 Hz only)	41-729-513
CR203	Diode, Zener, LMZX22A	66-393-402
CR204	Diode, Zener, LMZX22A	66-393-402
BR201	Diode bridge, BR84C	908-047-01
BR202	Diode bridge, BR84C	908-047-01
BR203	Diode bridge, BR84C	908-047-01

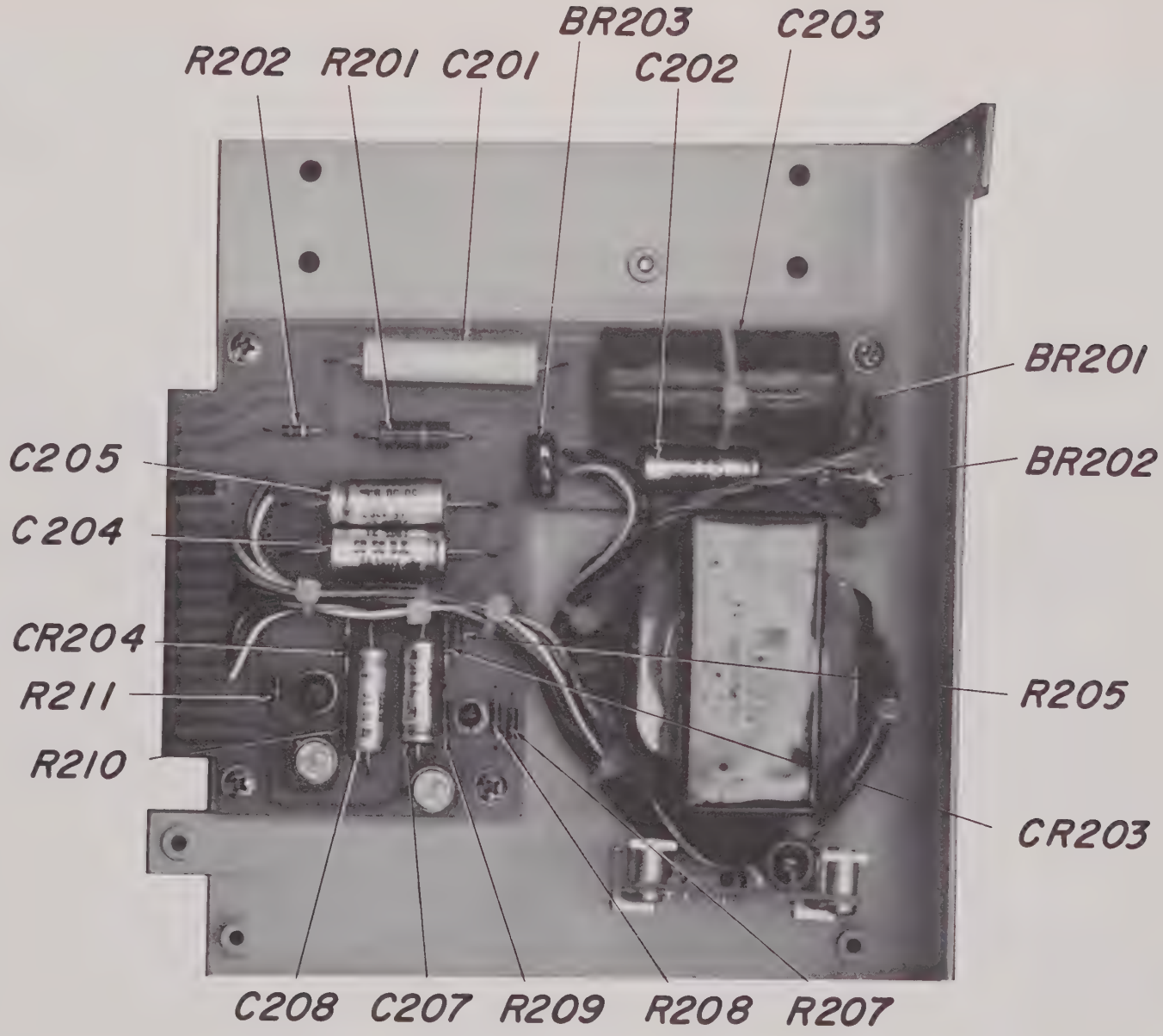


FIGURE 5-2 115V POWER SUPPLY P.C. BOARD

TABLE 5-2 Continued

Schematic Reference	Description	Varian Part Number
Q201	Transistor, 40319	62-989-600
Q202	Transistor, 2N3391A	62-003-391
Q203	Transistor, 2N3638	62-903-638
Q204	Transistor, 2N3053	62-003-053
R201	Resistor, 1.5K, 1w,5%	33-301-415
R202	Resistor, 560 ohms, 1/4, 5%	32-301-356
R205	Resistor, 1.8K, 1/4w, 5%	32-301-418
R206	Resistor, 1.8K, 1/4w, 5%	32-301-418
R207	Resistor, 150 ohms, 1/4w 5%	32-301-315
R208	Resistor, 1.2K, 1/4w, 5%	32-301-412
R209	Resistor, 2.2K, 1/4w, 5%	32-301-422
R210	Resistor, 2.2K, 1/4w, 5%	32-301-422
R211	Resistor, 1.2K, 1/4w, 5%	32-301-412
R212	Resistor, 150 ohms, 1/4w, 5%	32-301-315
Switch Assembly - Part No. D972-530		
R501	Resistor, 990K, 0.1%	31-613-280
R502	Resistor, 6K, 0.1%	31-613-281
R503	Resistor, 2K, 0.1%	31-613-282
R504	Resistor, 2K, 0.1%	31-613-282
R505	Potentiometer, 50K	971-568
R506	Resistor, 2.7K, 1/4w, 5%	32-301-427
R507	Resistor, 14K, 0.1%	31-613-274
R508	Resistor, 8.4K, 0.1%	31-613-275
R509	Resistor, 2.8K, 0.1%	31-613-276
R510	Resistor, 1.4K, 0.1%	31-613-277
R511	Resistor, 840 ohms, 0.1%	31-613-278
R512	Resistor, 280 ohms, 0.1%	31-613-279
R513	Resistor, 280 ohms, 0.1%	31-613-279
R514	Resistor, 20K, 1%	31-605-200
R515	Resistor, 11.3K, 1%	31-605-113
R516	Resistor, 8.66K, 1%	31-604-866
R517	Resistor, 4.99K, 1%	31-604-499
R518	Resistor, 2.49K, 1%	31-604-249
R519	Resistor, 1.5K, 1%	31-604-150
R520	Resistor, 499 ohms, 1%	31-603-499
R521	Resistor, 499 ohms, 1%	31-603-499

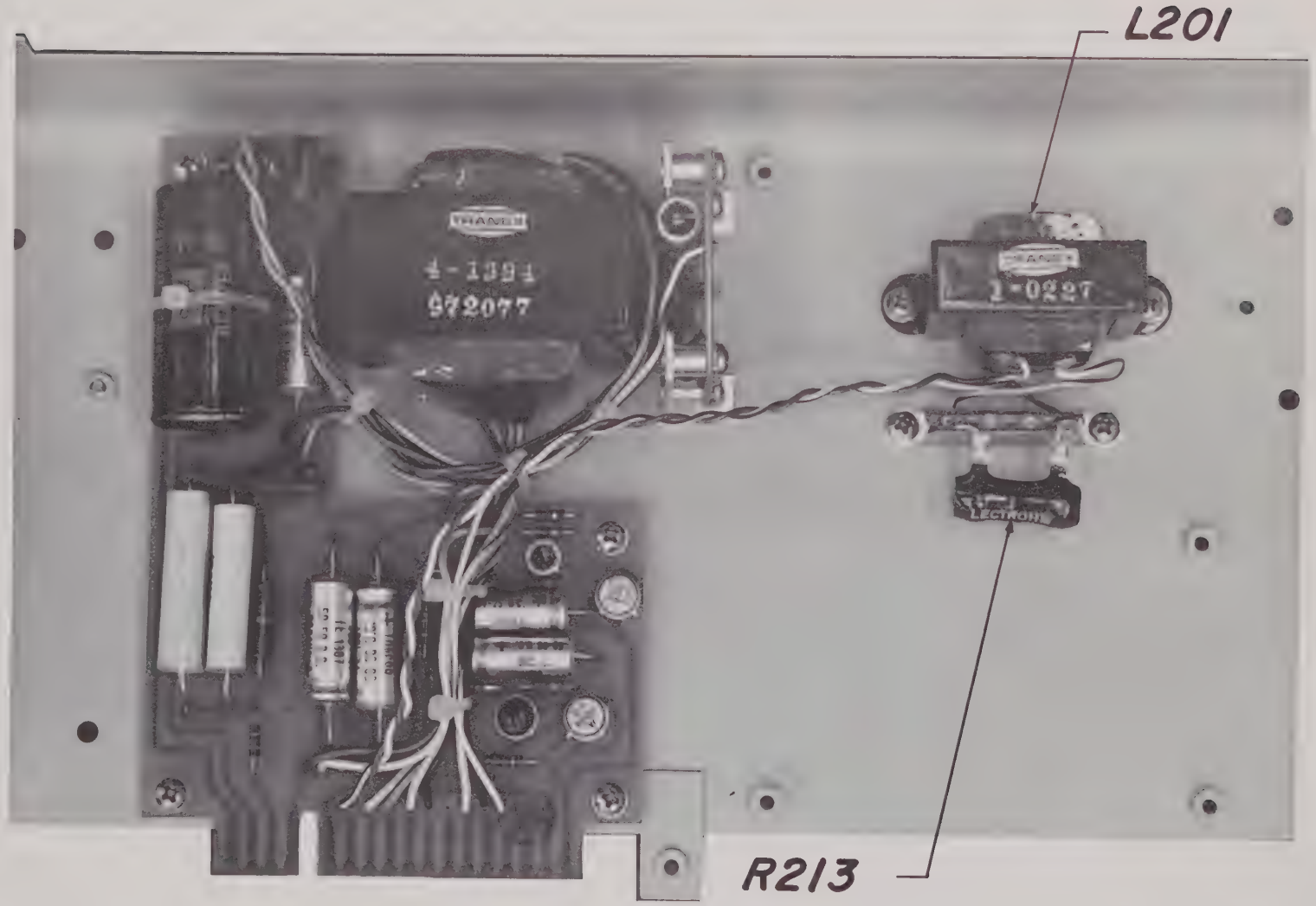


FIGURE 5-3
230V POWER SUPPLY

TABLE 5-3 ELECTRICAL PARTS LISTS - ACCESSORIES AND OPTIONS

Schematic Reference	Description	Varian Part Number
Electric Pen Lift Kit - Part No. B972-578		
CR303	Diode, SC2	66-396-832
L303	Solenoid	972-827
R303	Resistor, 51 ohms, 2w, ±5%	34-401-251
Accessory Power Supply Kit, Part No. A972-581		
C305	Capacitor, 50 mfd, 50 V	41-506-259
CR304	Diode, SC2	66-396-832
CR305	Diode, SC2	66-396-832
CR306	Diode, SC2	66-396-832
J406	Connector, receptacle	51-107-701
P406	Connector, plug	51-107-700
T301	Transformer, power	907-200

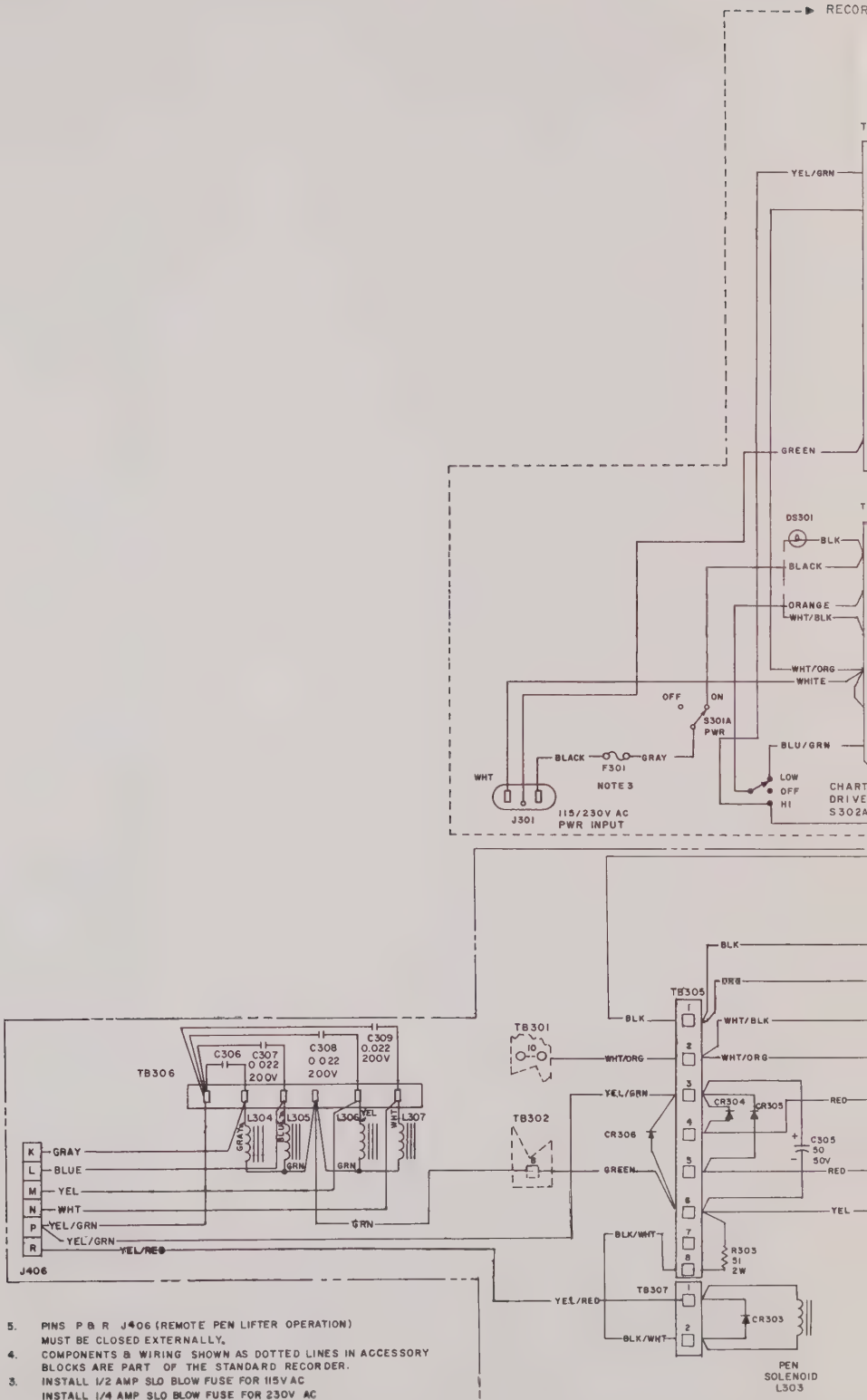
TABLE 5-4 REPLACEMENT PARTS, SUPPLIES, AND KITS

Description	Varian Part Number
Instruction manual	87-300-114
Ink cartridge, red	908-049-06
Ink cartridge, blue	908-049-07
Ink cartridge, black	908-049-08
Pen Assembly	972-464-01
Pen Filler	907-674
Pen cleaning wire	972-499
Motor oil	88-299-450
Chart-weight clip	972-529
Fuse	See para. 2.2
Drive cable	88-589-990
Span element	See Table II
Potentiometer, feedback	906-549
Neon lamp	67-499-961
Chart paper	See Varian Recorder Supplies Catalog
Alarm/Control switch kit(front)	972-466-01
Event Marker pen, right hand	972-641-01
Event Marker pen, left hand	972-641-02
Event Marker kit, right side	972-640-01
Event Marker kit, left side	972-640-02

SECTION 6
SCHEMATIC DIAGRAMS

This section contains the following schematic diagrams:

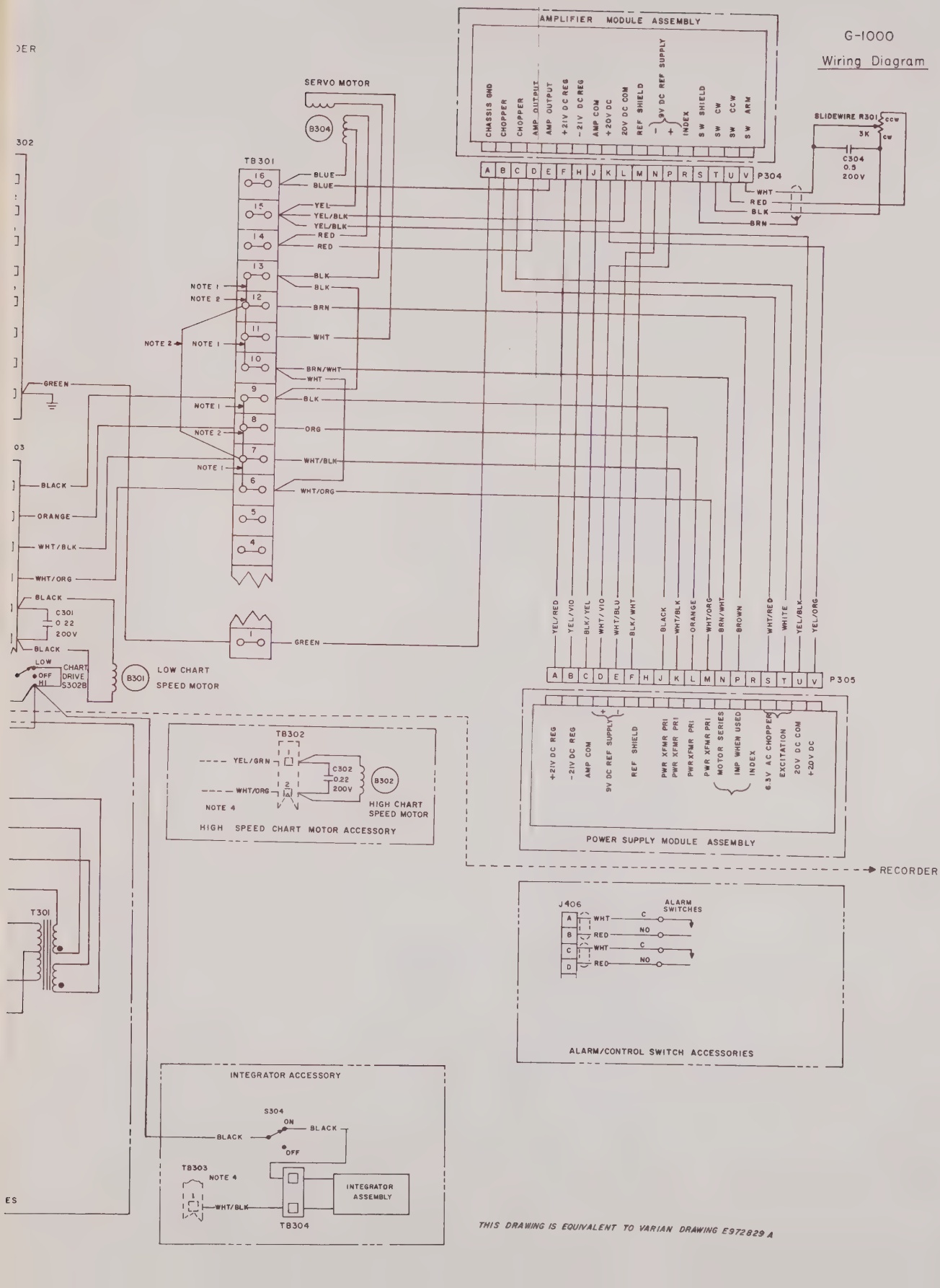
Varian Part Number	Title
972-829	Wiring Diagram
972-537	Amplifier Schematic
972-263	Power Supply Schematic
972-569	Parallel T Schematic

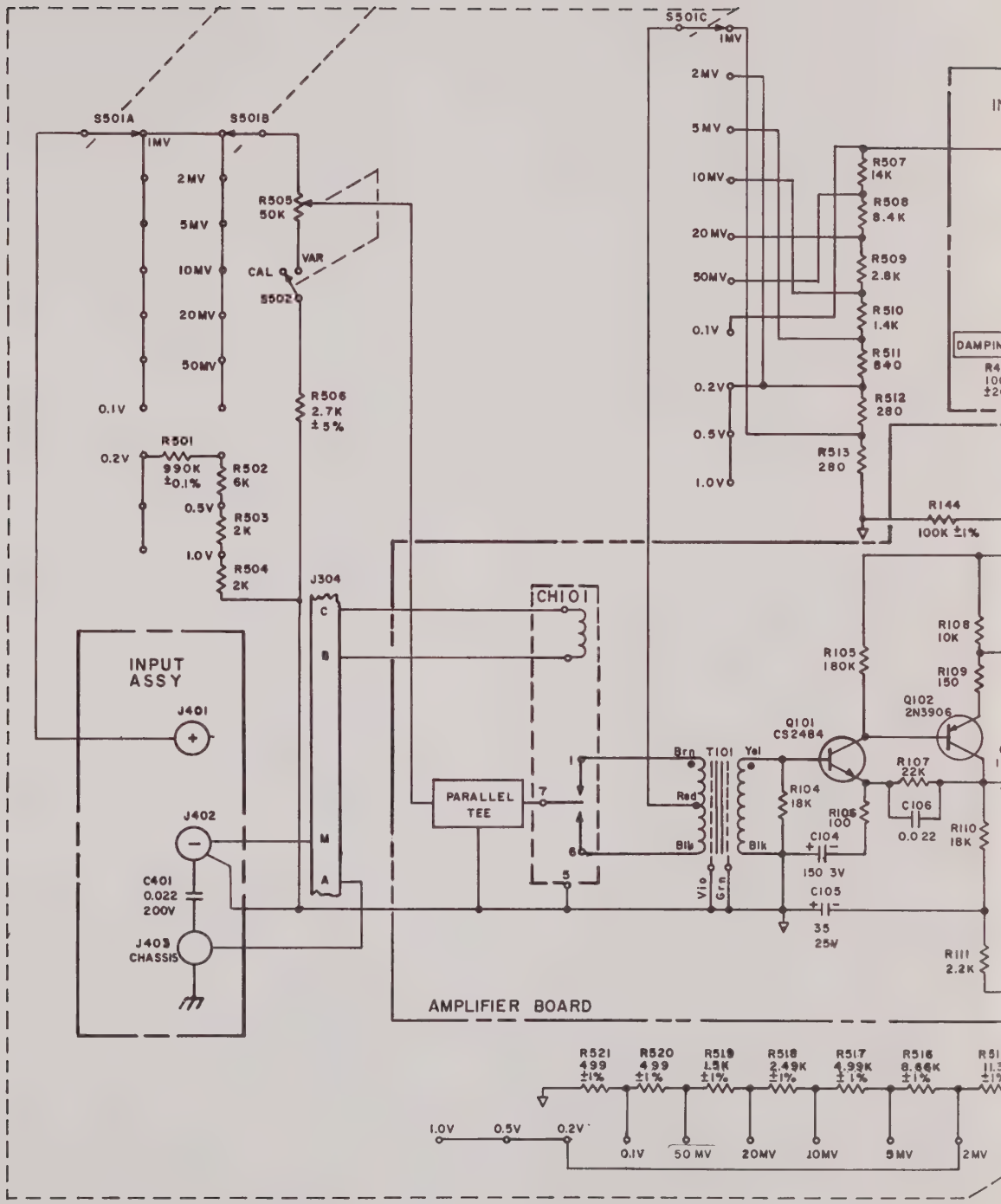


5. PINS P & R J406 (REMOTE PEN LIFTER OPERATION) MUST BE CLOSED EXTERNALLY.
4. COMPONENTS & WIRING SHOWN AS DOTTED LINES IN ACCESSORY BLOCKS ARE PART OF THE STANDARD RECORDER.
3. INSTALL 1/2 AMP SLO BLOW FUSE FOR 115V AC
   INSTALL 1/4 AMP SLO BLOW FUSE FOR 230V AC

2. INSTALL JUMPERS ONLY FOR 230V AC OPERATION (3 PLACES)
1. INSTALL JUMPERS ONLY FOR 115V AC OPERATION (4 PLACES)

NOTES:


G-1000
Wiring Diagram
AMPLIFIER MODULE ASSEMBLY
CHASSIS GND
CHOPPER
CHOPPER
AMP OUTPUT
AMP OUTPUT
+21V DC REG
-21V DC REG
AMP COM
+20V DC
20V DC COM
REF SHIELD
9V DC REF SUPPLY
INDEX
S W SHIELD
SW CW
SW CCW
SW ARM
P304
SERVO MOTOR
B304
TB301
SLIDEWIRE R301
CCW
3K
CW
C304
0.5
200V
WHT
RED
BLK
BRN
BLUE
YEL
YEL/BLK
RED
BLK
BRN
WHT
BRN/WHT
BLK
ORG
WHT/BLK
WHT/ORG
GREEN
NOTE 1
NOTE 2
BLACK
ORANGE
WHT/BLK
WHT/ORG
BLACK
C301
0.22
200V
LOW
OFF
HI
CHART DRIVE S302B
B301
LOW CHART SPEED MOTOR
YEL/RED
YEL/VIO
BLK/YEL
WHT/VIO
WHT/BLU
BLK/WHT
BLACK
WHT/BLK
ORANGE
WHT/ORG
BRN/WHT
BROWN
WHT/RED
WHITE
YEL/BLK
YEL/ORG
P305
TB302
YEL/GRN
WHT/ORG
C302
0.22
200V
B302
HIGH CHART SPEED MOTOR
NOTE 4
HIGH SPEED CHART MOTOR ACCESSORY
+21V DC REG
-21V DC REG
AMP COM
9V DC REF SUPPLY
REF SHIELD
PWR XFMR PRI
PWR XFMR PRI
PWR XFMR PRI
PWR XFMR PRI
MOTOR SERIES
IMP WHEN USED
INDEX
6.3V AC CHOPPER
EXCITATION
20V DC COM
+20V DC
POWER SUPPLY MODULE ASSEMBLY
RECORDER
J406
ALARM SWITCHES
WHT
RED
WHT
RED
C
NO
C
NO
ALARM/CONTROL SWITCH ACCESSORIES
T301
INTEGRATOR ACCESSORY
S304
ON
OFF
BLACK
BLACK
TB303
NOTE 4
WHT/BLK
INTEGRATOR ASSEMBLY
TB304
THIS DRAWING IS EQUIVALENT TO VARIAN DRAWING E972829 A

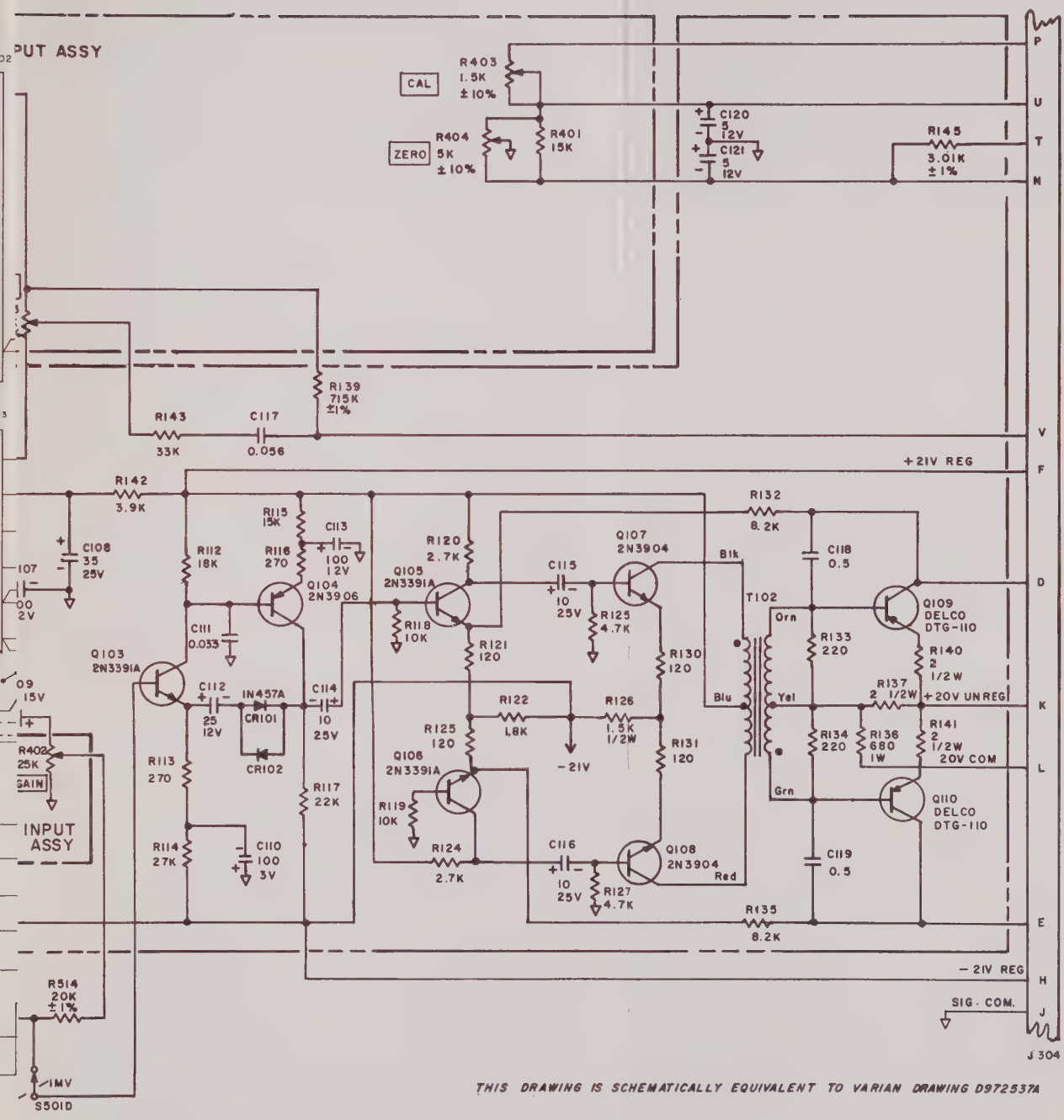


2. UNLESS OTHERWISE SPECIFIED:
   ALL RESISTOR VALUES IN OHMS, 1/4 WATT, ±5%
   ALL CAPACITOR VALUES IN MICROFARADS, 200V, ±20%

1. ⏚ CHASSIS GROUND; ⏚ SIGNAL GROUND; DC ISOLATED FROM EACH OTHER

NOTES:

Amplifier G-1000
Schematic Diagram



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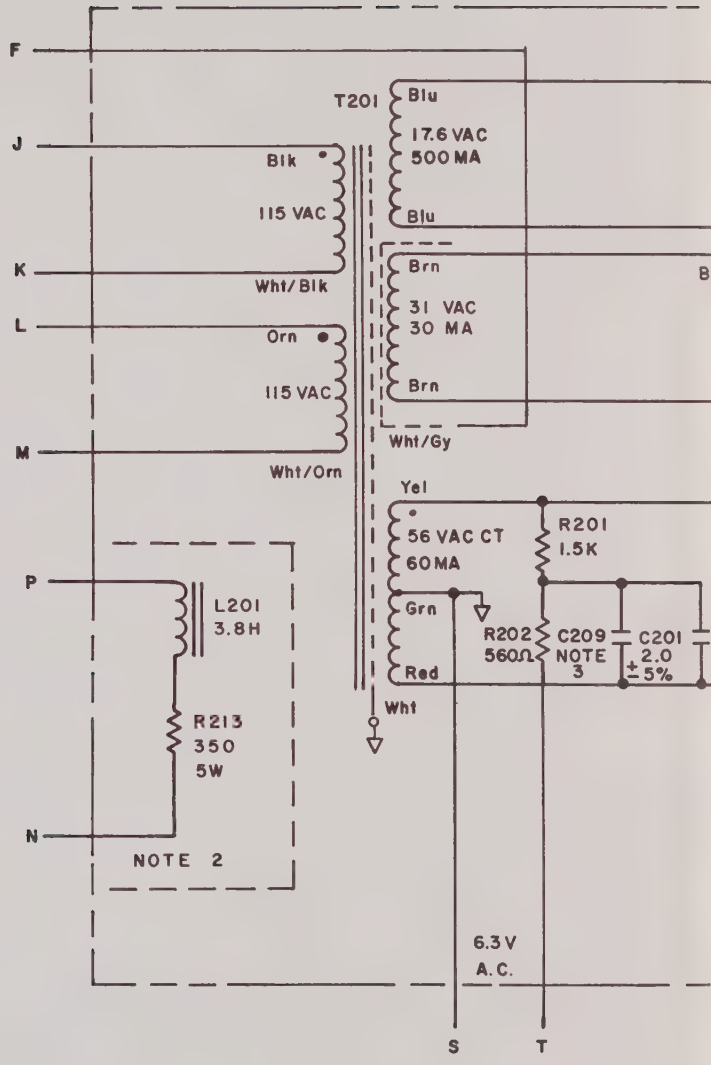
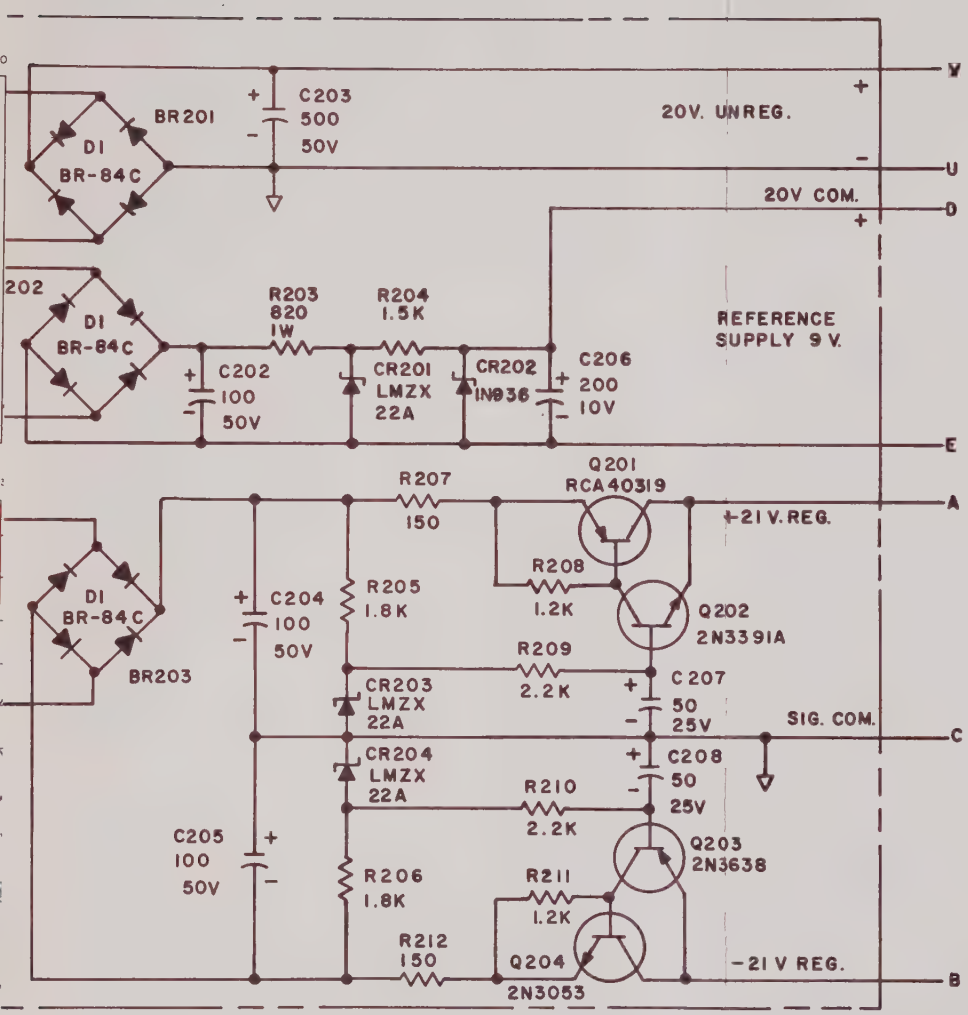


3. FOR 60HZ OPERATION C209 IS 0.5 µf 200V 5%
   FOR 50HZ OPERATION C209 IS 1.0 µf 200V 5%
2. L201 AND R213 USED ON 230 VOLTS AC
1. UNLESS NOTED OTHERWISE:
   ALL RESISTORS
   EXPRESSED IN OHMS
   1/4 WATT
   ±5%
   ALL CAPACITORS
   EXPRESSED IN MICROFARADS
   200V

NOTES: ±20%

Power Supply G-1000
Schematic Diagram



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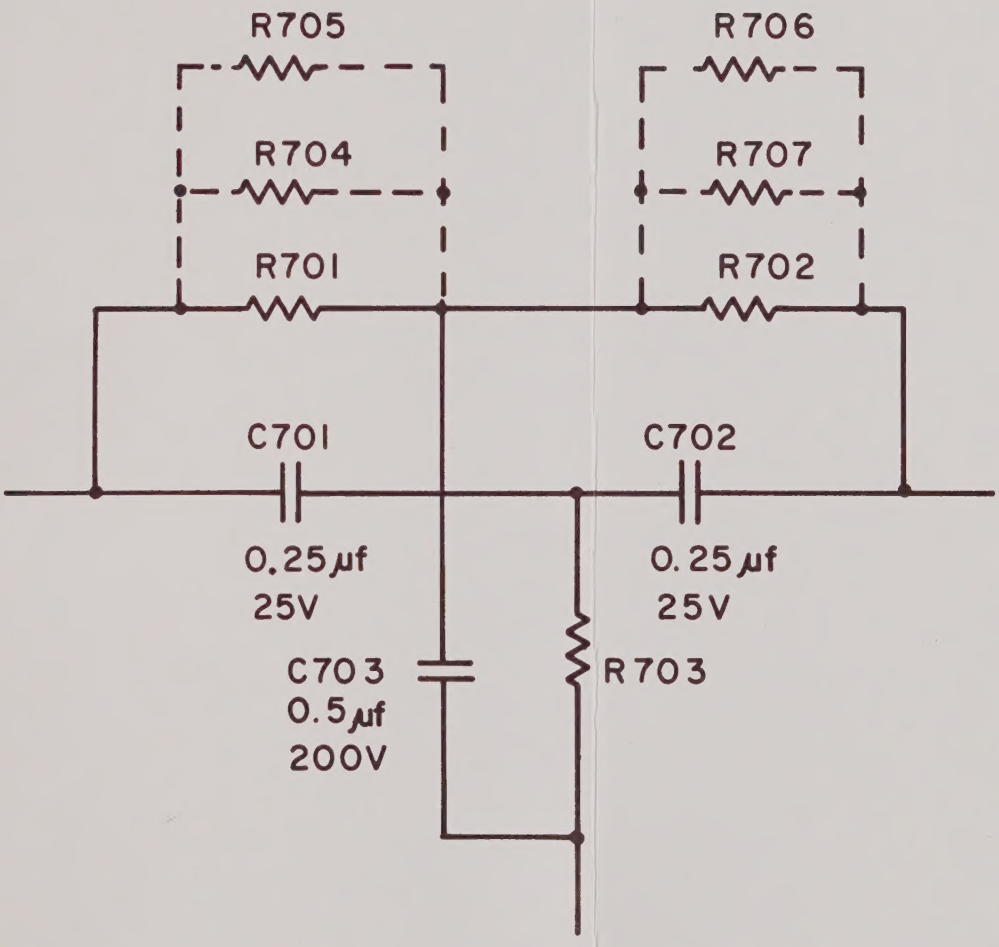
RESISTANCE VALUE TABLE 50Hz & 60Hz		
SCHEMATIC REF. NO.	50Hz	60Hz
R701	13.7K	11.3K
R702	13.7K	11.3K
R703	6.81K	5.62K

2. RESISTORS SHOWN IN DOTTED LINES SELECTED IN TEST FOR 50 OR 60Hz REJECTION RATIO OF AT LEAST 60 Db FROM A 600 OHM SOURCE IMPEDANCE.

1. ALL RESISTORS ±1%, UNLESS OTHERWISE SPECIFIED.

NOTES:

Parallel Tee G-1000
(50 and 60 Hz)
Schematic Diagram



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